Illinois U Library

PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

In Association with

THE PHYSICAL SOCIETY

THE AMERICAN PHYSICAL SOCIETY

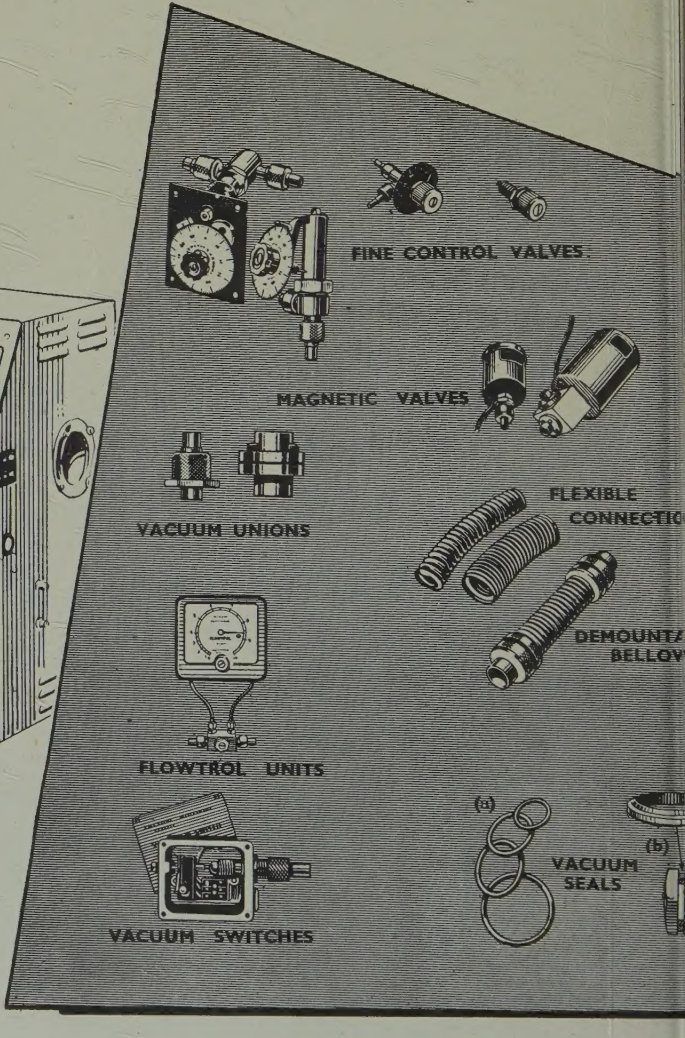
THE AMERICAN
INSTITUTE OF ELECTRICAL ENGINEERS

ABSTRACTS 5480–6239

OLUME 55 AUGUST 1952 NUMBER 656

precision VACUUM EQUIPMENT . . .

Needs 'SPEEDIVAC' PLUMBING and CONTROL DEVICES



The fabrication and maintenance of complicated vacuum systems is now reduced to a simple, foolproof procedure with the introduction of EDWARDS demountable "plumbing" and control devices, of which only a few are described below.

GAS CONTROL NEEDLE VALVES—Precision instrument-finished valves for the control of fine gas flows.

DEMOUNTABLE VACUUM PIPE UNIONS—Flanged or hand-tightened. 1/16th in. to 2 in. with "O" ring vacuum seals.

FLOWSWITCH AND FLOWMETER—Protective water flow switch. Switches off H.T., sounds alarms, etc., when water flow is inadequate.

VACUUM SWITCHES—For protective and automatic switching at pre-set gas pressures. Special types available for greater precision and lower vacuum.

MAGNETICALLY OPERATED VALVES—For controlling vacuum or non-corrosive gases and vapours.

FLEXIBLE CONNECTIONS AND BELLOWS—Corrugated metal tubing, flexible connectors with integral unions (bellows and reinforced rubber types); special rubber and synthetic tubing.

VACUUM SEALS—(a) Precision moulded, oil-resisting "O" rings and cord. (b) Bonded seals for demountable leak-proof closures.

for better vacuum service . . .

W. EDWARDS

& CO. (LONDON) LTD., LONDON, S.E.2

Telephone: Sydenham 7026 (8 Lines). Grams: Edcohivac, Souphone, L

Principal Contents

AUGUST 1952

		PAGE
51	MATHEMATICS	661
52	ASTRONOMY. ASTRO-PHYSICS. GEODESY	661
53	PHYSICS	664
530.1	Fundamentals	664
531	General mechanics. Mechanics of solids	670
531.7	Mechanical measurements	671
532	Mechanics of fluids	671
532.6	Capillarity	673
532.7	Molecular theory of liquids	673
533	Mechanics of gases	674
533.7	Molecular theory of gases	675
534	Vibrations. Acoustics	675
535	Optics. Radiation. Spectra	679
536	Heat	687
536.7/.8	Thermodynamics	692
537	Electricity	692
537.1	Theory. Electrons	692
537.2	Electrostatics. Dielectrics	693
537.3	Electric conduction. Currents	695
537.52	Electric discharges	698
537.531	X-rays	701
537.533/.534	Cathode rays. Positive rays	702
537.54	Discharge tubes. Counters	704
537.56/.58	Ionization. Thermionics	706
537.591	Cosmic rays	707
538	Magnetism	709
538.3/.5	Electromagnetism. Electrodynamics	713
538.56	Electromagnetic waves and oscillators	713
538.6	Magnetic effects	716
539.1	Molecular and atomic structure	716
539.11	Theory of solid state	716
539.13	Molecular structure	718
539.15	Atomic structure. Nucleus. Isotopes	721
539.16	Radioactivity, α-, β- and γ-rays	724
539.17	Nuclear reactions	729
539.18	Atom and molecular beams. Mesons. Neutrons	731
539.2	Structure of solids	734
539.3/.8	Elasticity. Strength. Rheology	734
541	PHYSICAL CHEMISTRY	739
541.11/.12	Phase equilibrium. Chemical reactions	739
541.13	Electrochemistry	740
541.14/.15	Photochemistry. Radiation chemistry	741
541.18	Dispersions. Colloids. Adsorption	742
541.2/.6	Chemical structure	742
542.1/.7	Laboratory apparatus	742
542.9	Chemical processes	—
543/545	Chemical analysis	742
548	CRYSTALLOGRAPHY	743
548.7	Molecular and X-ray crystallography	744
55	GEOPHYSICS	749
551.5	Atmosphere. Meteorology	750
57/59	BIOLOGY	751
61	Medical science. Human physiology	751
66/67	TECHNICAL MATERIALS	—
77	PHOTOGRAPHY	752

RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Mechanical testing
Non-destructive testing
Industrial radiography
Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

pH METER

AND MILLIVOLTMETER

The 'Pye' pH Meter is a mains-operated instrument which is virtually immune to the effects of supply variations. For a meter operating on 230 volts the supply may vary from 195 to 265 volts and from 47 c/s to 53 c/s in frequency without producing variations of more than 0.02 pH in the reading.

The instrument can be used to speed up any industrial process dependent upon acidity or alkalinity, thus reducing labour and production cost. Operation is extremely simple and a series of determinations can be taken by an unskilled operator with rapidity and ease. Zero adjustments need only be made once a day.

All accessories including electrodes and buffer tablets, are provided, stowed in a compartment within the instrument. The "Operating Instructions" are lucid and in simple language. Please write for descriptive leaflet, quoting Cat. No. S.A. 11054.

OUTSTANDING FEATURES

★ Mains Operated ★ Direct Reading ★ Automatic Temperature Compensation ★ Full Range 0-14 pH ★ Can be used with any electrode assembly ★ Operates external meters, recorders, process controllers ★ Electrode fully protected ★ Ideal for Redox-Millivolt measurements

Visit S.I.M.A. EXHIBITION AND SYMPOSIUM Sept 2nd-5th

SCIENTIFIC PYE INSTRUMENTS

W. G. PYE & CO. LTD., GRANTA WORKS, CAMBRIDGE, ENGLAND

MATHEMATICS 51

518.2 : 519.25

5480. Tables of the error function and of its first twenty derivatives. [STAFF OF THE COMPUTATION LABORATORY]. *Annals of the Computation Laboratory of Harvard University, Volume XXIII. Cambridge, Mass., Harvard University Press; London, Geoffrey Cumberlege* (1952) 304 *pp.*

"The present volume of six-place tables has been prepared to meet the requirements of applied statistics and modern physics. Most of the numbers given are new."

518.5

5481. Proceedings of a second symposium on large scale digital calculating machinery (1949). *Annals of the Computation Laboratory of Harvard University, Volume XXVI. Cambridge, Mass., Harvard University Press; London, Geoffrey Cumberlege* (1952) 432 *pp.*, 24 *plates.*

518.5

5482. The difference analyzer: a simple differential equation solver. G. A. KORN. *Math. Tables Aids Comput.*, **6**, 1–8 (*Jan.*, 1952).

Sets of linear or non-linear differential equations are solved by stepwise integration (rotary stepwise displacement of the shafts corresponding to the variables) as distinct from normal continuous integration (rate servo systems). Computation proceeds by the manual iteration of two simple operations. Estimation of error is demonstrated: accuracy is approx. that of the slide-rule. The instrument is more economical than a full differential analyser and can be made entirely automatic. A. J. KENNEDY

519.24 : 582 : 621.391

5483. Information theory and its application to taxonomy. D. K. C. MACDONALD. *J. Appl. Phys.*, **23**, 529–31 (*May*, 1952).

A possible source of confusion between the concept of information content and entropy in the theory of information is discussed and resolved. Information theory is then applied to the problem of taxonomy or classification of data and several models are discussed, representative of various possible methods of filing data with the purpose of determining the optimum size of filing-unit in relation to the given data. The possible fields of application envisaged include the classification of faults in a system, the statistical analysis of data or the indexing of books, letters, etc. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.615

5484. On a photoelectric relay recorder of high sensitivity. H. DAENE. *Z. Astrophys.*, **30**, 230–3 (*No.* 3, 1952) *In German.*

523.11

5485. Cosmology. H. BONDI. *Cambridge, Cambridge University Press* (1952) 179 *pp.*

Cosmology is presented as an independent branch of Physics. General principles and relevant observational material are discussed, and a critical examination is made of existing theories. In Part I, the application of the laws of terrestrial physics to cosmology is discussed, and various formulations of the cosmological principle are considered. Observational evidence likely to be relevant in cosmological investigations is considered in Part II. In addition to a survey of astrophysical and geophysical data, there is a detailed discussion of the background light of the sky, and a critical examination is made of the problem of inertia (Mach's principle). A stimulating discussion of Newtonian, relativistic and kinematic cosmologies is given in Part III, and steady-state theories are examined. A brief examination is also made of the theories of Eddington, Dirac and Jordan. A final chapter is concerned with suggestions for further theoretical and observational research. The bibliography provides a useful list of important books and papers. R. A. NEWING

523.165 : 523.854 : 621.396.62.029.63

5486. Measurement of radiations from the Milky Way on 1420 Mc/s. C. H. MULLER. *Tijdschr. Ned. Radiogenoot.*, **17**, 3–15 (*Jan.*, 1952) *In Dutch.*

An introduction to radio-astronomy and summary of world-wide activities, particularly investigations into the 1420 Mc/s line in the spectrum of galactic radiation. Requirements for radio-astronomical receivers are given, with details of principle, general circuit, sensitivity and aerial system for a crystal-controlled spectral line receiver. Initial measurements with a provisional installation in Holland indicate that a projected improved receiver should give much important information on the structure of the Milky Way. G. DU CLOUX

523.6

5487. Note on the origin of comets. R. A. LYTTLETON. Note in *Astrophys. J.*, **115**, 333–4 (*March*, 1952).

Planetary perturbations are shown to have no effect on the efficacy of the collision mechanism invoked in the accretion hypothesis for the formation of comets. M. W. OVENDEN

523.72

5488. Detection of millimeter wave solar radiation. W. M. SINTON. Letter in *Phys. Rev.*, **86**, 424 (*May* 1, 1952).

By the use of a special infrared telescope, radiation

in the 1–3 mm region has been detected from the sun, with an intensity about 1/15 that expected from a 6000°K black body. Water vapour in the atmosphere seems to be the chief attenuating agent; clouds appear transparent. G. M. BROWN

523.746

5489. On the foreshortening law of sunspots. M. HOTINLI. *Istanbul Univ. Obs. Yaz. A*, **16**, 278–94 (*No.* 42, 1951).

A simple method is given for determining the law of foreshortening of sunspots from the distribution of their numbers and areas over the visible hemisphere of the sun. By application of this method it is shown that spots are foreshortened in the ratio $\cos\alpha(1 - \mu\tan\alpha)$, where α is the heliocentric angular distance of the spot from the centre of the sun's disk and $\mu = 0{\cdot}075$, a simple physical interpretation being given. In the last section, using data collected by the American Association of Variable Stars Observers (AAVSO) under the title "Gleissberg Foreshortening Projects," observations made by different groups of observers are compared in order to determine for each of them the area of the smallest spot just large enough to be detected. Finally a curve is obtained by plotting these minimum areas against the factors k used in the reduction of the relative sunspots numbers to the Zürich scale. A.

523.75

5490. On the statistics of solar flares. A. BEHR AND H. SIEDENTOPF. *Z. Astrophys.*, **30**, 177–84 (*No.* 3, 1952) *In German.*

From data in the Quarterly Bulletin for the years 1935–1950, the numbers of flares per solar rotation, their relation to the sunspot relative numbers, and their distribution over the solar disk are examined. The visibility of a flare as a function of its heliographic longitude from the central meridian is derived. The ratio of the numbers of flares in the northern and southern solar hemispheres and its variation with time is discussed, and the fact is noted that in the current solar cycle the ratio between the number of flares and the sunspot relative number is some 25% less than in the previous cycle. M. W. OVENDEN

523.77

5491. Photoelectric measurements of the solar magnetic field. G. THIESSEN. *Z. Astrophys.*, **30**, 185–99 (*No.* 3, 1952) *In German.*

A photoelectric method of recording has been added to the author's interferometric method of measuring Zeeman shifts in Fraunhofer lines (1946). Observations (restricted to two points on the central meridian at heliographic latitudes $\pm 45°$) during 1949 and 1951 gave, on the assumption of a dipole field, polar field strengths of $-1{\cdot}5 \pm 0{\cdot}75$ gauss and $-2{\cdot}4 \pm 0{\cdot}5$ gauss respectively. Previous visual and photographic measurements are compared with these results. M. W. OVENDEN

523.77

5492. Some recent observations of helium lines in the infrared solar spectrum. O. C. MOHLER. Note in *Astrophys. J.*, **115**, 323–5 (*March*, 1952).

Equivalent widths of solar He I lines at 10 830·34, 10 830·25 and 10 829·08 Å (the first two unresolved) have been measured from microphotometer tracings of McMath–Hulbert i.r. spectrograms. Large variations are found for measures on the solar limb at poles and equator; and for quiet and disturbed solar regions. D. R. BARBER

523.77

5493. High-dispersion solar spectrograms between 15 μ and 24 μ. M. MIGEOTTE AND L. NEVEN. Note in *Astrophys. J.*, **115**, 326 (*March*, 1952).

Within the atmospheric transmission limits, $15{\cdot}9\ \mu$–$23{\cdot}7\ \mu$, high-dispersion spectra obtained for the first time, Oct. 1951, reveal 145 new absorption lines due principally to CO_2, N_2O and water-vapour.

D. R. BARBER

523.78

5494. Combined observations of the total eclipse of the sun of 1952, February 25, at Khartoum (Sudan) and of the partial eclipse with the radio telescope of the Meudon observatory. M. LAFFINEUR, R. MICHARD, J.-C. PECKER, M. D'AZAMBUJA, A. DOLLFUS AND I. ATANASIJEVIĆ. *C.R. Acad. Sci.* [*Paris*] **234**, 1528–30 (*April* 7, 1952) *In French.*

A brief summary of the instruments used and results obtained on visual and radio wavelengths by the expedition of the Bureau des Longitudes.

M. W. OVENDEN

523.78

5495. On the ellipsoidal form of the sun observed on metric waves. E.-J. BLUM, J.-F. DENISSE AND J.-L. STEINBERG. *C.R. Acad. Sci.* [*Paris*] **234**, 1597–9 (*April* 16, 1952) *In French.*

The solar eclipses of Sept. 1, 1951, and Feb. 25, 1952, were observed on 169 Mc/s. Nine per cent of the total radiation is occulted at first and fourth optical contacts, an amount incompatible, on a spherical model, with the residual 48% of radiation observed at maximum of eclipse. The model of the sun as a uniformly bright ellipsoid is able to reproduce the observed variation of intensity to an accuracy of 2%. M. W. OVENDEN

523.83

5496. The initial condition problem of stellar dynamics. R. KURTH. *Z. Astrophys.*, **30**, 213–29 (*No.* 3, 1952) *In German.*

If f_0, the velocity-space distribution function at time $t = 0$, is known, it is shown that the function $f(u, v, w; x, y, z; t)$ is uniquely determined and may be constructed by an iteration process in which f_0 is used to find a first approx. f_1, f_1 to find f_2, etc. A rigorous mathematical investigation is made of the conditions under which the sequence $f_0, f_1, f_2 \ldots$ converges uniformly to the unique solution f. Formulae are given from which estimates may be made of the time interval over which the solution is valid, and of the error $|f - f_1|$ involved in the 1st approx. R. A. NEWING

523.841.37

5497. Variation of effective temperature and radius of a Cepheid. R. CANAVAGGIA AND J.-C. PECKER. *C.R. Acad. Sci.* [*Paris*] **234**, 1739–41 (*April* 28, 1952) *In French.*

Monochromatic magnitudes in conjunction with a series of four model atmospheres form the basis of a graphical method for deriving relations between

effective temperatures and radii of Cepheid variables. Based on Stebbins's 6-colour photometry measures, the method is applied to δ Cephei; both effective temperature and radius changes are in phase with magnitude change, a result at variance with existing interpretations based on radial-velocity measures.

D. R. BARBER

523.851.2

5498. The luminosity and structure of the globular clusters. R. KURTH. *Z. Astrophys.*, **30**, 200–12 (*No.* 3, 1952) *In German.*

Correlation between brightness and distance holds for the globular clusters. A large portion of each cluster is composed of "invisible" stars which tend to concentrate in the central regions. D. R. BARBER

523.851.2

5499. The distances of the globular clusters. W. LOHMANN. *Z. Astrophys.*, **30**, 234–47 (*No.* 3, 1952) *In German.*

It is shown that the dependence of cluster-diameter on interstellar absorption is pronounced, and that after correction half of the diameter measures depart from the mean by a factor of at most 1·2. Interstellar absorption, diameter, distance modulus and distance are tabulated for 94 clusters. D. R. BARBER

523.852

5500. On critical flattening in the sequence of galaxies. H. FABRE. *C.R. Acad. Sci.* [*Paris*] **234**, 1526–8 (*April* 7, 1952) *In French.*

The occurrence of young stars in spiral nebulae provides evidence against the evolution of ellipsoidal into spiral forms. It is suggested that the cleavage between the *E* and *S* sequences may, nevertheless, be explained in terms of instability at a critical eccentricity, there being little evolutionary change in geometric form. R. A. NEWING

523.852.22

5501. Optical thickness and He II–H-line intensities in planetary nebulae. K. WURM AND O. SINGER. *Z. Astrophys.*, **30**, 153–63 (*No.* 3, 1952) *In German.*

523.852.22

5502. The planetary nebulae as ionized hydrogen regions. H. C. VAN DE HULST. Note in *Astrophys. J.*, **115**, 331–3 (*March*, 1952).

It is maintained that the computations of Page and Greenstein [Abstr. 7478 (1951)], which show that formulae relevant to the assumption that not enough quanta are available to keep the entire nebula ionized can be worked out consistently, does not prove the correctness of the assumption; consistent formulae using the same data could be developed on the assumption that not all the original quanta are consumed. M. W. OVENDEN

523.855

5503. A survey of the inner metagalaxy. H. SHAPLEY. *Amer. Scientist*, **39**, 610–28 (*Oct.*, 1951).

A summary of the methods and results of the Harvard survey of the metagalactic region to about 100 million light years. The clustering of galaxies, the obscuration by galactic dust (including evidence for absorption of up to $\frac{1}{2}$ m in the N.P.S. region) and the prevalence in the metagalaxy of dwarf spheroidal and irregular systems are emphasized. M. W. OVENDEN

523.877

5504. Stability of stars under variable Γ. R. S. KUSHWAHA AND P. L. BHATNAGAR. *Proc. Nat. Inst. Sci., India*, **18**, 13–19 (*Jan.–Feb.*, 1952).

The fundamental mode of oscillation of a model star is studied for two cases: (i) homogeneous model; (ii) model for which density varies inversely as square of distance from centre, taking Γ as function of r_0, distance of point considered from centre of star, giving continuous decrease in Γ from centre to surface. The two models become dynamically unstable for values of average Γ equal to 1·430 and 1·364 respectively. For the same law of variation of Γ, the second model is the more stable [see also Abstr. 2394 (1952)]. D. R. BARBER

523.877 : 539.17

5505. Nuclear reactions in stars without hydrogen. E. E. SALPETER. Note in *Astrophys. J.*, **115**, 326–8 (*March*, 1952).

Most nuclear processes in contracting, He-rich, main-sequence stars, types O and B, require temperatures *c.* 10^9 °K. However, the conversion of 3 He nuclei into the C nucleus takes place at the much lower temperature, *c.* 2×10^8 °K. It is concluded that a few per cent of all visible stars, mass $5\times M_\odot$, or larger, are converting He into heavier nuclei, the central temperature being *c.* 10 times higher than that of a main-sequence star of similar mass. D. R. BARBER

523.877 : 539.17

5506. A note on energy generation in red dwarf stars. L. H. ALLER, J. W. CHAMBERLAIN, E. M. LEWIS, W. C. LILLER, J. K. MCDONALD, W. H. POTTER AND N. E. WEBER. Note in *Astrophys. J.*, **115**, 328–30 (*March*, 1952).

Attempts to compute a model of the red-dwarf, Krueger 60A, based on energy production by the proton-proton reaction, and an atmosphere similar to the sun, prove unsatisfactory, the model star being always too luminous. With atmospheres composed almost wholly of He the reaction might be possible; although the mechanism of the red-dwarf stars may be explained satisfactorily in terms of the C cycle.

D. R. BARBER

525.3

5507. Poincaré's double resonance, and the wanderings of the terrestrial poles. H. FABRE. *C.R. Acad. Sci.* [*Paris*] **234**, 1667–9 (*April* 21, 1952) *In French.*

To explain the observed surface displacements of the earth's geographical poles over geological epochs, the Poincaré double-resonance effect of luni-solar precession is invoked [*Bull. Astron.* [*Paris*] **27**, 321–56 (1910)]. D. R. BARBER

526.5

5508. Chains of radial triangulation with measurements of distance (aerial polygonation). K. REICHENEDER. *Dtsch. Akad. Wiss. Berlin, Veröff Geodät. Inst. Potsdam, No.* 6, 39 *pp.* (1951) *In German.*

Sequel to an earlier paper [Abstr. 6013 (1951)] which had been criticized on the ground that in practical aerial surveying distances as well as angles are measured; this paper is a study of chains of radial triangulation in which central vertices whose

images lie at the centres of successive survey photographs are connected with each other and with auxiliary vertices on either side of the line of centres by measurements of the angles subtended at the central vertices and of distances between central vertices. The errors of the calculation of central vertex distance on the ground from distances measured on the photograph plate are discussed and practical methods of calculation are given. The theory of calculation and of the propagation of errors in a polygon chain are outlined, and aerial survey polygonation by this method and by the construction of chains of diamond figures with only one measured base are compared. A. H. COOK

526.7

5509. A new gravity formula for the Far East. H. HIGASINAKA. *Proc. Japan. Acad.*, **27**, 577–81 (*Nov.*, 1951).

529.77 : 621.317.36

5510. The estimation of absolute frequency in 1950–51. H. M. SMITH. *Instn Elect. Engrs Monogr.* 39, 6 *pp.* (*May* 15, 1952) [To be published also in *Proc. Instn Elect. Engrs, Pt IV*, **99**].

The degree of precision attained by modern frequency standards has rendered Greenwich Mean Time unsuitable as a basis for the assessment of performance. In order to provide a more uniform time system for the estimation of absolute frequency, corrections for quasi-periodic errors must be applied. It is shown that the annual fluctuation observed from 1934 to 1949 is no longer applicable; the value determined for 1950–51 shows a diminution of 40% in amplitude. This change caused difficulties in the Greenwich Time Service during the past two years, and gave rise to frequency errors amounting to $1\frac{1}{2}$ parts in 10^8. The existence of changes of this nature in the annual fluctuation is a hitherto unsuspected difficulty in the establishment of a uniform time system for the standardization of frequencies to an adequate accuracy. Attention is drawn to the difficulties inherent in the isolation and measurement of annual fluctuation and a method has been developed for evaluating it over single 12-month periods. This permits quarterly revision of the corrections adopted in current work. It is now possible to present a more reliable estimate of the stability attained by frequency standards of the latest type, and a numerical criterion of performance is proposed. A.

529.786 : 621.396.615

5511. Note on the effect of noise on the frequency of a valve oscillator. A. BLAQUIÈRE. *C.R. Acad. Sci.* [*Paris*] **234**, 1140–2 (*March* 10, 1952) *In French.*

In the previous notes [Abstr. 3256–7 (1952)] the effects on frequency and amplitude are discussed separately, the frequency being assumed to be independent of amplitude. This is not generally true and the indirect effect of the amplitude changes on frequency is greater than the direct effect of the noise. Analytical expressions are given. L. ESSEN

PHYSICS 53

53.082

5512. Increase of the sensitivity of measuring apparatus by resonance. J. GUITTON. *J. Phys. Radium*, **13**, 171–2 (*March*, 1952) *In French.*

The benefit of increased response obtained at resonance can be extended to the measurement of constant quantities provided the measuring instrument used has a natural period. The action to be measured is suitably interrupted and the frequency of interruption adjusted until the measuring instrument is put into resonance. S. WEINTROUB

FUNDAMENTALS 530.1

530.112

5513. Is there an æther? L. INFELD; P. A. M. DIRAC. Letters in *Nature* [*Lond.*] **169**, 702 (*April* 26, 1952).

Dirac's new field equations [Abstr. 981 (1952)] may be rewritten so as not to require an æther, but Dirac suggests that æther velocities are required in a Hamiltonian formulation of the equations [see also Abstr. 748 (1952)]. R. A. NEWING

530.12

5514. Action as a coordinate of space. V. YU. B. RUMER. *Zh. Eksper. Teor. Fiz.*, **21**, 1403–11 (*No.* 12, 1951) *In Russian.*

For Pt IV, see Abstr. 6724 (1951). Deals with the role of the scalar χ-potential which occurs in 5-optics in addition to the gravitational and electromagnetic potentials. 5-optics is based on the possibility of formulating the problem of classical and quantum mechanics of the movement of a "test" particle with given ratio e/m in gravitational and electromagnetic fields as a problem of geometrical and wave optics on the propagation of rays in the 5-space of configurations of the space, time and action co-ordinates, the metric tensor of which contains the ratio e/m of the test particle and also depends on a scalar χ-potential not so far used in physics. The problem of geometrical 5-optics (classical mechanics) is formulated by means of the equation of the 5-eikonal and in this only the local "microscopic" characteristics of the 5-space are important, but not the "macroscopic" topological structure of this space. By contrast, the problem of the wave 5-optics involves the solution of a boundary problem and here the topological structure of the 5-space becomes important. For ensuring agreement with experiments it has to be assumed that the configurational 5-space of the test particle is topologically closed through the co-ordinate of action, i.e. that all the $G^{\mu\nu}$ are periodical functions of the action co-ordinate with a period equal to Planck's constant h. The necessity of the introduction of the χ-potential follows from the fact that the system of the 15 Einstein-equations would be over-determined if the 5-field had only 14 gravitational and electromagnetic components (i.e. the

14 potentials g^{ik}, g^i); it would then be impossible to determine the component Q_{55} of the tensor of the sources independently. The paper treats Schwarzschild's problem as a simple variational problem, which is a considerable simplification. The solution of Kepler's problem of the movement of a test particle (probe) in the field of a charged mass is also considered and its solutions compared with those of Einstein's theory of gravitation. The final part is devoted to the interesting energy relations of 5-optics. B. F. KRAUS

530.12

5515. Development of a unitary field theory based on Finsler geometry. J. I. HORVÁTH AND A. MOÓR. *Z. Phys.*, **131,** 544–70 (*No.* 4, 1952) *In German.*

Presents the fundamentals of Finsler geometry and derives its extremals, which become the world lines of charged mass points in the unitary field theory which is then developed in the framework of this geometry. To generalize the techniques of relativity theory, tensor densities, variational methods and generalized Palatini and Bianchi identities in Finsler geometry are discussed, and a variation principle is given from which the field equations follow. R. H. DALITZ

530.12

5516. The formulation of the laws of conservation of energy and momentum in the general theory of relativity. M. KOHLER. *Z. Phys.*, **131,** 571–602 (*No.* 4, 1952) *In German.*

The gravitational field is described in terms of two metric tensors, g_{ik} satisfying Einstein's field equations and $\bar{g}_{ik}$ defining a flat space-time. The quantities g_{ik}–$\bar{g}_{ik}$ are interpreted as gravitational potentials, and the "field intensities" $\{jk, i\}$ are expressed as $\rho^i_{jk} + \overline{\{jk, i\}}$, the tensor ρ^i_{jk} representing the intrinsic gravitational field, and $\overline{\{jk, i\}}$ defining "inertial forces" dependent upon the frame of reference. Fundamental results of the general theory are restated in terms of this double-metric system which enables certain non-tensor quantities to be re-expressed in covariant form. The pseudo energy-tensor-density t^n_m of the gravitational field is replaced by a true tensor quantity defined in terms of the ρ^i_{jk}, and the conservation law is expressed in terms of covariant differentiation with respect to $\bar{g}_{ik}$. In applications to weak gravitational fields, a symmetric energy-momentum tensor is constructed, and for static fields the energy density is $\propto |\text{grad}\phi|^2$, where ϕ is the Newtonian potential. R. A. NEWING

530.12

5517. The elementary basic principles of the unified theory of relativity. V. HLAVATÝ. *Proc. Nat. Acad. Sci.* [*Wash.*] **38,** 243–7 (*March,* 1952).

The investigation is concerned with the introduction of (*a*) a non-symmetric tensor g_{ik}, (*b*) a non-symmetric connection, and (*c*) an apparently overdetermined system of conditions imposed on (*b*), but only a summary is given of the results obtained. It is suggested that (*a*) leads in a natural way to the theory of spinor space. R. A. NEWING

530.12

5518. Particular solutions of Einstein's recent unified theories. G. BANDYOPADHYAY. *Indian J. Phys.*, **25,** 257–61 (*May,* 1951).

530.12 : 530.145

5519. A canonical formulation of relativistic mechanics and its analogue in quantum theory. G. FALK. *Z. Phys.*, **132,** 44–53 (*No.* 1, 1952) *In German.*

It is shown that if energy and time are regarded as conjugate variables, the motion of a charged particle can be defined in terms of the Hamiltonian function $f(M)$, where $M = \sqrt{\{g^{ik}(p_i - e\phi_i)(p_k - e\phi_k)\}} = m$ the rest-mass, the independent variable being arc-length along the world line $\div (df/dM)_{M=m}$. The transition to quantum mechanics is discussed for the metric of special relativity, with $f(M) = M^2$ which is now a rest-mass operator and is found to have a continuous spectrum for static fields. A rest-mass operator with a discrete spectrum would provide a theory of elementary particles. R. A. NEWING

530.12 : 530.145

5520. Relativity and indeterminacy. H. BONDI. Letter in *Nature* [*Lond.*] **169,** 660 (*April* 19, 1952).

It is argued that the existence of a maximum speed of propagation is incompatible with a fully deterministic physical theory, and hence that relativity is logically tenable only when classical determinism is abandoned. R. A. NEWING

530.14

5521. The motion of centre of gravity and the variation of the width of wave packets. P. V. SEREBRYANYĬ. *Zh. Eksper. Teor. Fiz.*, **20,** 1130–8 (*No.* 12, 1950) *In Russian.*

The motion of wave packets of limited size, in a homogeneous and isotropic medium with any given dispersion, is investigated with a view to evolving the law of motion of the centre of gravity and the variation of the width of the packet. In the formulae used for the definition of the centre of gravity and the width, the square of the amplitude of the field plays the part of the density, and on this basis the centre of gravity is defined in the usual way, while the width is defined as the square root of the ratio between the moment of inertia with reference to the centre of gravity and the total mass of the packet. The integration is extended to the whole space and all frequencies of the Fourier integral. In the general case the width expands according to a quadratic function of time. Waves of a scalar and waves of a vector are investigated separately. Special attention is given to the case of plane waves and particularly to the e.m. waves. It is shown that in a non-dispersing medium the velocity of a packet of e.m. waves other than plane is always less than the velocity of light and is in fact equal to the velocity of a particle of the same energy and momentum. N. S. JAPOLSKY

530.14

5522. On the relativistic connection between frequency, wavelength, phase velocity and group velocity. J. L. SYNGE. *C.R. Acad. Sci.* [*Paris*] **234,** 1669–70 (*April* 21, 1952) *In French.*

From considerations of relativistic invariance, the relations given by de Broglie [Abstr. 39 (1948)] expressing frequency and phase velocity in terms of group velocity and wavelength are shown to be valid only if the group velocity has the form $U(\lambda) = c/\sqrt{(1 + A\lambda^2)}$. R. H. DALITZ

530.145

5523. A probability-theoretical foundation for, and interpretation of, quantum mechanics. I. FÉNYES. *Z. Phys.*, **132**, 81–106 (*No.* 1, 1952) *In German.*

It is shown that, for Markoff processes, a probability amplitude function may be defined, and that certain indeterminacy relations exist which correspond to the Heisenberg uncertainty relations in quantum mechanics. Wave mechanical processes may then be interpreted as special Markoff processes, and the Fokker equation holds for their probability function $\psi^*\psi$. It is concluded that the Heisenberg relations arise, not from the disturbance due to measurement, but from the statistical nature of the theory, and that an interpretation of wave mechanics in terms of "hidden parameters" is possible if von Neumann's restrictive requirement of deterministic parameters is given up. A statistical derivation of Schrödinger's equation is given, based on a statistical Lagrange principle. R. H. DALITZ

530.145

5524. The quantum of action and its place in the framework of natural constants. J. FUCHS. *Acta Phys. Austriaca*, **5**, 349–75 (*No.* 3, 1952) *In German.*

A discussion of the dimensional analysis of physical theory, suggesting that α, e, ε_0, μ_0 and $\lambda = e^2\mu_0/m_e$ should be regarded as the 5 primary natural constants. Then $h = (\mu_0/\varepsilon_0)^{\frac{1}{2}}e^2/2\alpha$ is a derived constant, and the quantum nature of elementary processes is considered to be linked with the discreteness of charge.

R. H. DALITZ

530.145

5525. The analogy between Hamilton–Jacobi theory and quantum-mechanical eigenvalue problems. G. FALK. *Z. Phys.*, **131**, 470–80 (*No.* 4, 1952) *In German.*

Analogies between the solution of the Hamiltonian–Jacobi equation and of the q.m. eigenvalue problem are pointed out, with special reference to the method of separation of variables. Lie's method for determining integrals of Hamilton's differential equations may be used to separate the eigenvalue equation in suitable co-ordinates. R. H. DALITZ

530.145

5526. The problem of three bodies in quantum mechanics. S. D. MAJUMDAR. *Z. Phys.*, **131**, 528–37 (*No.* 4, 1952).

The 3-particle Hamiltonian H is expressed in terms of the sides of the triangle formed by the 3 particles and its Eulerian angles, and the wavefunctions ψ_{em} are expanded in symmetrical top wavefunctions $U_{em\tau}$. Operation of H on U_τ produces terms $U_{\tau+2}$, U_τ, $U_{\tau-2}$ with coefficients whose properties are discussed here. The use of this method is illustrated by reference to the D-states of He (neglecting nuclear motion). R. H. DALITZ

530.145

5527. On the interpretation of quantum mechanics by means of hidden variables in the sense of M. David Bohm. R. DUGAS. *C.R. Acad. Sci.* [*Paris*] **234**, 1599–601 (*April* 16, 1952) *In French.*

Compares Bohm's attempt [Abstr. 2413–14 (1952)] to interpret quantum mechanics in terms of a scheme of determinate hidden variables with Hertz's considerations on the possibility of hidden variables in classical theories. R. H. DALITZ

530.145

5528. Quantization of wave fields with a finite number of components. V. I. KARPMAN. *Zh. Eksper. Teor. Fiz.*, **21**, 1337–49 (*No.* 12, 1951) *In Russian.*

Discusses quantization of wave fields describing particles with arbitrary spins and satisfying relativistic-invariant equations with a finite number of dimensions. The theory of the c-numbers requires that for spins proceeding by halves the charge be positively determined, and for integer spins the energy be positively determined. This principle yields general expressions for the transposition relations, of which some examples (particle of spin $\frac{1}{2}$, particles of spins 0 and 1, particle of spin $\frac{3}{2}$) are given at the end of the paper. The investigation of the structure of the transposition relations shows that if fields for particles with an integer spin are quantized according to Bose statistics, and fields with half-spins according to Fermi statistics, the transposition relations will not contain the so-called second invariant function D'. This does not apply if the quantization is carried out in some other way. Since the presence of the function D' in the transposition relations is incompatible with the general principles of the relativistic quantum theory, it is proved that all the wave fields of a finite number of dimensions are susceptible of quantization according to the generalized Pauli principle, and only according to this principle. This may be taken as the most general demonstration of the generalized Pauli principle for particles with several spin states and rest masses. B. F. KRAUS

530.145

5529. Some remarks on the Tomonaga–Schwinger fundamental equation of electrodynamics. S. ALBERTONI. *Nuovo Cim.*, **8**, 168–79 (*Suppl. No.* 2, 1951) *In Italian.*

A critical review of the bases of this new electrodynamics. The equation of motion for two interacting dynamical systems (e.g. electrons and radiation field) are reconstructed in covariant form.

L. PINCHERLE

530.145

5530. On an electromagnetic wave picture of microprocesses. H. W. KÖNIG. *Acta Phys. Austriaca*, **5**, 286–318 (*No.* 3, 1952) *In German.*

From an analysis of classical e.m. wave fields, based on the author's earlier work [Abstr. 7521 (1951)] and by comparison with their quantum theory interpretation, the author is led to the results $1/\alpha = \pi^4\sqrt{2} = 137{\cdot}757$ (α = the fine-structure constant). Other elementary constants are then derived and the experimental data discussed. R. H. DALITZ

530.145

5531. Spontaneous light-emission in unitary quantum-electrodynamics. G. SÜSSMANN. *Z. Phys.*, **131**, 629–62 (*No.* 4, 1952) *In German.*

From Ludwig's quantization [Abstr. 4086 (1951)] of Wheeler–Feynman electrodynamics, Einstein coefficients are calculated using a simple absorber model, the radiation field out-going from the absorber being treated in first Born approximation. These agree with the usual values. R. H. DALITZ

530.145

5532. On non-linear electrodynamics. K. BECHERT. Note in *Naturwissenschaften*, **39**, 185 (*No.* 8, 1952) *In German.*

A non-linear electrodynamic theory is developed, satisfying the requirements discussed previously [Abstr. 73 (1951)]. The equations of the theory are identical in form to those of Dirac's theory [Abstr. 981 (1952)] but differ in origin and interpretation.

R. H. DALITZ

530.145

5533. The intermediate coupling theory of the pseudoscalar meson-nucleon interaction. P. T. MATTHEWS AND A. SALAM. *Phys. Rev.*, **86**, 715–26 (*June* 1, 1952).

Tomonaga's intermediate coupling theory for scalar mesons is extended to pseudoscalar mesons with pseudoscalar coupling. The single free nucleon is discussed. Recoil is included non-relativistically and the divergences are removed arbitrarily by a cut-off at the nucleon rest mass. Effects involving one virtual pair are allowed for, on the assumption that two or more virtual pairs may be neglected. The calculations are of a preliminary nature and certain possibilities for refining them are discussed. As they stand, they indicate that even for $f^2/4\pi \simeq 10$, a renormalized weak coupling expansion should give a very slowly converging, but not entirely distorted picture of the meson cloud surrounding a nucleon for pseudoscalar coupling. A.

530.145

5534. The electron neutron interaction. B. D. FRIED. Letter in *Phys. Rev.*, **86**, 434 (*May* 1, 1952).

This is calculated using ps.-scalar mesons, ps.-scalar coupling, weak coupling perturbation theory to 2nd order and the Feynman–Dyson techniques. The "equivalent well depth" of the interaction is found to be $-5{\cdot}38$ keV in agreement with experiment (-5 ± 1 keV) and the discrepancies between earlier calculations of Case [Abstr. 5943 (1949)], Borowitz and Kohn [Abstr. 1514 (1950)] and Foldy [Abstr. 7534 (1951)] are explained. W. J. SWIATECKI

530.145

5535. Exchange current effects in the deuteron. F. VILLARS. *Phys. Rev.*, **86**, 476–83 (*May* 15, 1952).

It is well known that the existence of charge-carrying nuclear fields, resulting in an exchange of charge between nucleons, also gives rise to additional electromagnetic interaction terms for the nuclear system. It is commonly assumed that these effects are zero for the deuteron ground state, on account of the symmetry properties of the exchange current. The present investigation aims to draw attention to the fact that this conclusion is only true in the adiabatic approximation, which neglects the recoil of the nucleons. In the expression for the electromagnetic interaction of charge-exchanging nucleons in motion, nuclear "two-particle currents" appear, in addition to the meson currents encountered in the adiabatic approximation. Whereas the latter are antisymmetric under charge exchange of a nucleon pair, the former are not, and give rise to electromagnetic exchange effects for the deuteron ground state. A.

530.145

5536. On the representation of the wave equations of particles of spin 0 or $\hbar$. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **234**, 1534–7 (*April* 7, 1952) *In French.*

The calculation of the trace of a product of the de Broglie matrices $\Gamma_\mu = \gamma_\mu^{(1)} + \gamma_\mu^{(2)}$ is simplified by use of projection operators $\eta^\pm$ which project the space on which Γ_μ acts into the sub-spaces corresponding to fields of spin 0 and of spin $\hbar$. The Kemmer–Duffin β-matrices for these spin values are thus given by $\beta_\mu = \Gamma_\mu \eta^\pm$ respectively. R. H. DALITZ

530.145

5537. Triton binding energy by a randomized net-point method. S. I. RUBINOW. *Phys. Rev.*, **86**, 388–90 (*May* 1, 1952).

A numerical procedure is investigated for solving Schrödinger's equation for a system of particles. A net-point analysis is applied directly to the integral equation equivalent to Schrödinger's equation. A unique feature is the introduction of the concept of a "randomized" net of points. This is designed to cope with the problem of obtaining adequate covering of the space when many dimensions are involved. The method is applied to the problem of finding the binding energy of the triton with the assumption of central forces. The result obtained for an exponential potential as determined by the most recent low-energy scattering data is approximately 10% too deep. It may be concluded that more effective repulsion must be introduced into the "equivalent central potential" to bring about agreement with experiment. A.

530.145

5538. An analysis of the self-energy problem for the electron in quantum electrodynamics. P. N. DAYKIN. *Canad. J. Phys.*, **30**, 70–8 (*Jan.*, 1952).

Feynman's S-matrix for the self-energy of the free resting electron is evaluated without the restriction that the virtual photons in the intermediate state have only positive energy. Both the one-electron theory and the hole theory of the positron are treated. It is shown that in the one-electron theory the normally quadratically divergent transverse part of the self-energy vanishes if the photon field is assumed to be symmetric in positive and negative energies. A similar theorem does not hold in the hole theory. A particular type of interaction leads to a vanishing self-energy in one-electron theory. However, this does not solve the self-energy problem, as in this case radiation corrections to scattering would vanish as well. The S-matrix for the self-energy of a bound electron is evaluated in a similar manner. The decay probability for an excited state is calculated as the imaginary part of the self-energy. The correct value is obtained only in hole theory and in interaction with positive energy photons. In the special case in which the external field is a uniform magnetic field, again only hole theory with this same interaction gives the correct value for the anomalous magnetic moment. A.

530.145

5539. On the electromagnetic Coulomb scattering of particles of spin 0, $\hbar/2$ or $\hbar$. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **234**, 1601–3 (*April* 16, 1952) *In French.*

Covariant calculation of the cross-section (in 1st Born approx.) for scattering between two particles A

and B, of spins 0, $\hbar/2$ or $\hbar$, due to exchange of one photon between them. R. H. DALITZ

530.145

5540. On the calculation of the scattering cross-sections for particles of spins 0, $\hbar/2$ and $\hbar$ through a scalar or pseudoscalar meson field. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **234,** 1749–51 (*April* 28, 1952) *In French.*

For two particles, each having spin 0, $\frac{1}{2}$ or 1, interacting with a sc. or psc. meson field, the cross-section for mutual scattering is calculated covariantly using methods described in preceding abstract and Abstr. 5536 (1952). R. H. DALITZ

530.145

5541. Multiple scattering of waves. M. LAX. *Rev. Mod. Phys.*, **23,** 287–310 (*Oct.*, 1951).

Previous work on multiple scattering of waves is summarized, and Foldy's procedure [Abstr. 1349 (1945)] is generalized to cases where there is anisotropic or inelastic scattering, or creation or absorption of particles, and to include effects arising from the partial ordering and motion of the scatterers, showing that the relation $k'^2 = k^2 + 4\pi ncf$ connects the propagation constant k' to its value k in absence of scattering, where f is the amplitude for forward elastic scattering, n the density of scatterers and c a measure of their correlation. The coherence and incoherence of the scattering is discussed in some detail. The total radiation satisfies an integral equation whose inhomogeneous term is the coherent radiation, and an expression is derived for the angular distribution of the scattering by the medium. The equivalence between this multiple-scattering approach and the many-particle approach for collision with a complex system is found to be dependent on the closure approximation, the error of which is shown to depend on the initial momentum distribution and to be negligible at high energies.

R. H. DALITZ

530.145

5542. Derivation of the dispersion formula from the theory of forced, damped nuclear vibrations. S. KRONENBERG. *Acta Phys. Austriaca,* **5,** 341–8 (*No.* 3, 1952) *In German.*

Sexl's method [*Z. Phys.*, **115,** 571–7 (1940)] of derivation of the resonance formula for pure elastic scattering is extended to the case where absorption also occurs, leading to the Breit–Wigner result.

R. H. DALITZ

530.145

5543. The scattering theory of the Schrödinger equation. D. PARK. *Amer. J. Phys.*, **20,** 293–300 (*May*, 1952).

The Schrödinger equation for the scattered particle is converted into an integral equation, in which the kernel is obtained by the use of the condition that the events described by the solutions of the equation must be causally related, i.e. that causes must always precede the effects which they produce. The integral equation is iterated once, and it is found that its solution corresponds to the usual description of a scattering process in terms of an undeflected wave traversing the system plus a radially scattered wave moving outwards. In the second part, it is shown that a simple relation exists between solutions of Schrödinger's equation of the sort just described and the solution of the initial-value problem associated with the equation of motion for a free particle. By this means a solution of the scattering problem is set up which describes how the wave function develops as the wave which it describes propagates through the system. The series which results was first given by Feynman. As an example, the first Born approximation for the scattering problem is developed by each approach. A.

530.145

5544. On correlation in multiple scattering in the magnetic field. V. I. OGIEVETSKIĬ. *Zh. Eksper. Teor. Fiz.*, **21,** 775–9 (*No.* 7, 1951) *In Russian.*

The magnetic field is $\perp^r$ to the plane of motion of the charged particle and changes arbitrarily along the axis of motion. Fixation of C strongly restricts angular distribution at B when the particle has passed points A, B, C. An additional 4th point has little further influence. J. JACOBS

530.145

5545. On the theory of multiple scattering of charged particles. F. SAUTER AND H. WANKE. *Z. Naturforsch.*, **7a,** 33–9 (*Jan.*, 1952) *In German.*

Through a rigorous transformation of the integral equation arising in the problem of multiple scattering into a differential equation an approximation procedure is obtained for determining the angular dependence of the scattered intensity. The order of magnitude of the mean square deviation is the same as in Molière's theory, but there is no arbitrariness in the definition of $\overline{\theta^2}$. W. J. SWIATECKI

530.145

5546. The angular distribution of scattered nucleons in high energy nuclear collisions. H. MESSEL AND H. S. GREEN. *Proc. Phys. Soc.* [*Lond.*] *A,* **65,** 245–9 (*April*, 1952).

The theory of the mean square angle of emission of nucleons resulting from a high energy nucleon-nucleus collision is developed. Graphical results are given both for light and for heavy nuclei. A.

530.145

5547. Comparative models in nuclear scattering. D. C. PEASLEE. *Phys. Rev.*, **86,** 269–71 (*May* 1, 1952).

The "optical" and "compound" methods for treating nucleon-nucleus encounters are compared on the basis of a very simple model. It is concluded that the optical procedure is valid for incident energies $E > \sim 80$ MeV, the compound for $E < \sim 30$ MeV. The statistical model of the excited nucleus can be applied only when the excitation energies of individual nucleons may all be considered to be within the lower limit. For π-mesons incident on nuclei similar considerations show that the optical method must be used under all circumstances. A.

530.145

5548. The problem of the radiative corrections to the scattering cross-section of an electron in a Coulomb field and the Bloch–Nordsieck method. G. MORPURGO. *Nuovo Cim.*, **8,** 109–55 (*Suppl. No.* 2, 1951) *In Italian.*

A clear up-to-date review of the subject. In Part I the various perturbation calculations that have been

carried out are discussed and it is shown how a correct application of the procedure, together with re-normalization of mass and relativistic corrections, eliminates from the theory all the well-known divergencies. Part II discusses the re-elaboration by Fierz and Pauli of the Bloch–Nordsieck method and compares its results with those of the perturbation calculations. L. PINCHERLE

530.145

5549. Pion-proton scattering and the strong coupling meson theory. G. WENTZEL. *Phys. Rev.*, **86**, 437–9 (*May* 15, 1952).

From the pseudoscalar charge-symmetric strong coupling meson theory, scattering cross-sections are derived for meson energies well below resonance and at resonance with an excited nucleon state. A.

530.145

5550. A new remark on the collisions between electrons and atoms. S. KICHENASSAMY. *C.R. Acad. Sci.* [*Paris*] **234**, 1530–2 (*April* 7, 1952) *In French.*

A method is given for carrying out the "collision complex" theory of electron scattering described earlier [Abstr. 4129 (1952)] similar to the method used in the author's work [Abstr. 1684 (1952)] on interaction of matter and radiation, which is justified here. R. H. DALITZ

530.145

5551. On spinor representations. F. L. BAUER. *C.R. Acad. Sci.* [*Paris*] **234**, 1743–4 (*April* 28, 1952) *In French.*

An expression is given for the number of times that the representation of the orthogonal group $0(n)$, which is specified by the partition $\{m_1, m_2 \ldots m_\nu\}$, appears in the direct product of N representations each given by $\{\frac{1}{2}, \frac{1}{2} \ldots \frac{1}{2}\}$. Michel's result [Abstr. 3341 (1951)] concerning the number of tensors constructible from four spinors is then deduced [see also Abstr. 781 (1952)]. R. H. DALITZ

530.145

5552. The virial theorem for a Dirac particle. M. E. ROSE AND T. A. WELTON. Letter in *Phys. Rev.*, **86**, 432 (*May* 1, 1952).

Corresponding to the classical relativistic virial theorem, a virial theorem is proved in the relativistic quantum theory of a spin $\frac{1}{2}$ particle, from which is derived a number of identities satisfied by Dirac wave functions. R. H. DALITZ

530.145

5553. On the relativistic theory of nuclear forces. IV. Calculation of the neutron-proton interaction produced by a pseudoscalar field. M. LÉVY. *C.R. Acad. Sci.* [*Paris*] **234**, 1671–2 (*April* 21, 1952) *In French.*

For Pt III, see Abstr. 4909 (1952). Here, the neutron-proton interaction produced by a symmetric charged pseudoscalar meson field is calculated using methods developed earlier [Abstr. 4135 (1952)].

R. H. DALITZ

530.145

5554. On the relativistic theory of nuclear forces. V. The properties of the neutron-proton system at small energies. M. LÉVY. *C.R. Acad. Sci.* [*Paris*] **234**, 1744–6 (*April* 28, 1952) *In French.*

Using a neutron-proton potential which agrees with the result obtained from symmetric psc. meson theory in orders g^2 and g^4 for $r > r_0$, but which is strongly repulsive for $r < r_0$ (as relativistic calculation not based on perturbation theory suggests), all low energy n–p data is well accounted for by a reasonable choice of parameters g^2 and r_0. R. H. DALITZ

530.145

5555. A test for the charge-symmetry hypothesis. R. L. GARWIN. Letter in *Phys. Rev.*, **85**, 1045 (*March* 15, 1952).

The charge-symmetry hypothesis for meson-nucleon coupling may be tested for a state of total isotopic spin $\frac{1}{2}$ by comparison of the reactions

$$d + p \begin{cases} \nearrow d + n + \pi^+ \\ \searrow d + p + \pi^0 \end{cases}.$$

R. H. DALITZ

530.145

5556. Renormalized *S*-matrix for scalar electrodynamics. A. SALAM. *Phys. Rev.*, **86**, 731–44 (*June* 1, 1952).

By a consistent use of the concepts of mass and charge renormalization, Dyson [Abstr. 6740, 7523 (1951), 3279 (1952)] has demonstrated the possibility of constructing a divergence-free S-matrix for scattering problems in spinor-electrodynamics, valid to all orders in the fine-structure constant. In this paper a proof is given of the possibility of renormalizing theories of charged scalar (or pseudoscalar) particles in the presence of the electromagnetic field. It is found that in addition to the renormalization of mass and charge, an infinite constant of direct interaction $\delta\lambda$ has to be introduced in a term $\delta\lambda\phi^{*2}\phi^2$ added to the Hamiltonian, in order to cancel consistently all divergences arising from the Møller scattering of one spinless particle by another. This, combined with the fact that theories of charged scalar and pseudoscalar mesons in scalar interaction with the nucleons can be renormalized with the same additional term in the Hamiltonian, seems to be of some significance. A.

530.145

5557. On the convergence of the perturbation method. T. KATO. *J. Fac. Sci. Tokyo Univ.*, **6**, 145–226 (*Pt* 3, 1951).

An attempt to construct a rigorous mathematical theory of the perturbation method which will cover nearly all cases of practical importance. The approach is abstract and is based on the known theory of operators in Hilbert space. Chapter I gives a simplified account of regular perturbations when the formal series which arises in the perturbation method converges. When the series does not converge one can regard it as an asymptotic series, thus extending the range of applicability of the method (Chapter II). These considerations do not cover weakly quantized systems (e.g. the Stark effect), which are therefore discussed separately in Chapter III. The concluding chapter deals with the applications of the method to the equations of motion. This problem is the most difficult one and the theory less complete.

P. T. LANDSBERG

530.145

5558. On the Hamiltonian operator of two quantized fields in interaction. L. VAN HOVE. *Bull. Acad. Roy. Belg. Cl. Sci.*, **37**, 1055–72 (*No.* 12, 1951) *In French.*

For all the usual field theories and their interaction energies, it is shown that neither the interaction energy H_I nor the total energy H can be considered as operators in S_0, the Hilbert space spanned by the eigenfunctions of the non-interacting field Hamiltonians, as is implied in the conventional perturbation theories, since for any vector ϕ in S_0, $H\phi$ and $H_I\phi$ do not belong to S_0. R. H. DALITZ

530.145

5559. Motion of an electron in a perturbed periodic potential. E. N. ADAMS, II. Letter in *Phys. Rev.*, **86**, 427 (*May* 1, 1952).

The function $\xi^{\mu}_{n,n}$ introduced previously [Abstr. 1479 (1952)] in discussing the validity of Luttinger's generalization [Abstr. 1868 (1952)] of Wannier's theory, may be chosen, in every case, to be a constant X^{μ}_{n}, which is the mean electron coordinate in the Wannier localized wave-function $\phi_{ln}(x)$. For motions in a slowly-varying magnetic field, Luttinger's Hamiltonian should then be changed to $E_n[p + \frac{e}{c}A(x + X_n)]$.

R. H. DALITZ

530.145.6

5560. On the formulation of diffusion problems. G. RIDEAU. *C.R. Acad. Sci.* [*Paris*] **234**, 1746–9 (*April* 28, 1952) *In French.*

See Abstr. 6039 (1951). The deduction is attempted of the transition amplitudes of a system under the influence of a potential of unlimited duration, starting from those relative to finite duration of action. A comparison with the earlier results of Schwinger tends to invalidate one of his equations. A.

530.162

5561. Brownian movement and electrical effects. M. BENDER AND H. MOUQUIN. *J. Phys. Chem.*, **56**, 272–8 (*Feb.*, 1952).

Previous theoretical work, while showing that the classical theory of Brownian movement leaves much to be desired, does not however provide an alternative general theory. Aiming at a better understanding, extensive experimental work using both deep and shallow cells has been undertaken, the amplitude and particle size being measured simultaneously and also the charges on particles and cell walls. Einstein's equation for displacement is shown to be approximately correct though allowance must be made for ionic content of the medium and the charges on particles and cell walls. Even when the suspensions were at the isoelectric point flocculation did not necessarily occur. Many of the findings of other workers are explained, e.g. the stopping of motion, found by Taggart [*J. Phys. Chem.*, **36**, 13 (1932)] and others, when electrolytes are added, is shown to be due to adherence to the cell walls. T. C. TOYE

530.162 : 536.423.4

5562. The condensation phenomenon of an ideal Einstein–Bose gas. O. HALPERN. Letter in *Phys. Rev.*, **86**, 126 (*April* 1, 1952).

A renewed investigation of this phenomenon has led to a revision of some accepted views. A distribution law over the various states of momentum is obtained different from that given by F. London (1938). For an ideal E–B gas in the earth's gravitational field the usual separation into two phases is found, but now the condensed phase no longer occupies the total available volume, but only a very thin layer at the bottom of the containing vessel. Such an ideal condensed gas cannot be realized, however, as the interatomic forces will become predominant, making the gas non-ideal, before the conditions for its existence are satisfied. A more detailed paper is to follow. R. H. DAVIES

GENERAL MECHANICS
MECHANICS OF SOLIDS 531

531.18 : 530.12

5563. The relativistic deformations of a rotating cylinder. M. GALLI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **12**, 86–92 (*Jan.*, 1952) *In Italian.*

A conceptual experiment first suggested by Wood (*Physical Optics*, Vol. II) is discussed in detail and it is shown that it leads to Ives's formulae (1939) for the torsion and longitudinal contraction of the cylinder. L. PINCHERLE

531.3

5564. A conservation theorem in classical mechanics. H. T. EPSTEIN. Note in *Amer. J. Phys.*, **20**, 308–9 (*May*, 1952).

A generalization of the usual energy integral of the equations of motion is deduced, useful in certain simple varying-mass problems. J. G. OLDROYD

531.565

5565. Free fall on the rotating earth. H. BUCERIUS. *S.-B. Math.-Nat. Kl. Bayer. Akad. Wiss.*, 1950, 77–83 (1951) *In German.*

The equations of motion of the earth are usually integrated approximately, neglecting the centrifugal terms. It is shown that the equations are rigorously integrable when these terms are retained. The results are compared with the approximate solution. The strong solution may be of practical interest for motions in constant gravitational fields when the time of fall of an object (e.g. a rocket) is an appreciable fraction of a day. MATHEMATICAL REVIEWS

531.578

5566. Theory of jet formation by charges with lined conical cavities. E. M. PUGH, R. J. EICHELBERGER AND N. ROSTOKER. *J. Appl. Phys.*, **23**, 532–6 (*May*, 1952).

An article by Birkhoff, MacDougall, Pugh, and Taylor [Abstr. 3117 (1948)] presented hydrodynamic theories of jet formation and target penetration by explosives with lined conical cavities. However, it was unable to explain satisfactorily why the jets produced are several times as long and, therefore, several times as effective as the steady-state theory predicts. It is shown here that these difficulties are overcome by assuming a variable instead of a constant collapse velocity for the walls of the conical liner.

The variability in the collapse velocity produces a surprisingly large change in the process of jet formation. A.

531.578

5567. Experimental verification of the theory of jet formation by charges with lined conical cavities. R. J. EICHELBERGER AND E. M. PUGH. *J. Appl. Phys.*, **23**, 537–42 (*May*, 1952).

Experimental evidence is presented that verifies the assumptions and conclusions reported in the preceding abstract. A graphical method of predicting the shape of the jet and slug at every instant is presented. A.

MECHANICAL MEASUREMENTS 531.7

531.717.7

5568. Accuracy of spherometer measurements. H. SCHULZ. *Optik*, **9**, 164–6 (*No.* 4, 1952) *In German.*

For a ring type spherometer head, the radius of the ring cannot be taken as constant when the highest accuracy is required. The apparent radius has been found to vary in a linear fashion with the radius of the surface being measured. A correction chart for the spherometer head can be drawn. R. W. FISH

531.761 : 537.591.2 : 621.317.755

A high speed chronograph. *See Abstr.* 5885

531.761 : 621.319.51 : 621.387 : 621.317.79

5569. Electronic spark timing device. A. BARDÓCZ AND A. KEMÉNY. Note in *Amer. J. Phys.*, **20**, 244–5 (*April*, 1952).

A condenser connected in series with the primary of a Tesla transformer is allowed to discharge periodically through a thyratron, the grid of which is controlled by means of a multivibrator circuit modified to give large positive voltage pulses. The multivibrator is synchronized from the 50 c/s mains supply and any of the integral subharmonics can be selected by varying the circuit constants. The spark gap connected to the secondary of the Tesla transformer will then discharge and create time marks at a frequency $\leqslant 50$ c/s. G. HOWELLS

531.765 : 621.317.79

5570. Circular sweep chronograph for single millisecond time intervals. A. LINZ, JR. *Rev. Sci. Instrum.*, **23**, 199–203 (*May*, 1952).

A chronograph is described which measures single time intervals up to 1000 μsec with an accuracy of ± 10 mμsec. The instrument consists of a 100 kc/s counter chronograph with a 10 μsec circular sweep to interpolate between scaler readings. Suitable pulse-sharpening circuits and a five-tube, high-speed gate circuit in which the pulses defining the timing interval form the edges of the gate are also described. The possibility of extending the precision of the time measurement to ± 1 mμsec is indicated. A.

531.787

5571. A universal two-liquid micromanometer. T. M. VASILISHIN AND Z. D. IPATOVA. *Zh. Tekh. Fiz.*, **21**, 448–52 (*No.* 11, 1951) *In Russian.*

An inclined, inverted U-tube micromanometer is described, which obtains a gain in sensitivity by using two immiscible liquids of differing specific gravities, the lighter liquid forming an indicating column in the central portion of the U-tube. F. QUELON

531.787.6

5572. An electrostatic differential manometer with a sensitivity of 2×10^{-6} torr/scale division. E. W. BECKER AND O. STEHL. *Z. angew. Phys.*, **4**, 20–2 (*No.* 1, 1952) *In German.*

A detailed description is given of the construction and associated electronic circuits. A cylindrical metal box is divided perpendicular to its axis by a 15 μ thick Al foil into two gas-tight compartments. The pressure difference between the compartments is measured by the bending of the foil which alters the relative capacitances of the condensers formed by the foil and the top and bottom of the box respectively. These two condensers form two arms of a capacitance h.f. bridge and the bridge current is amplified, rectified and measured with a microammeter. The calibration curve given shows that the sensitivity of the manometer is constant for pressure differences up to $\pm10^{-3}$ torr and is independent of the absolute pressure (50–760 torr). The sign of the applied pressure is given by the sign of the ammeter deflection. The high constancy of the zero point setting is demonstrated. S. WEINTROUB

MECHANICS OF FLUIDS 532

532.123 : 539.215.9 : 539.31

Stability of the elastic equilibrium of materials. The case of bodies without cohesion and liquids. *See Abstr.* 6086

532.13

5573. The influence of internal damping on the viscosity [of liquids] under electric fields. J. VAN CALKER AND B. AUBKE. *Z. Phys.*, **131**, 443–55 (*No.* 4, 1952) *In German.*

The effect of electrical fields of varying frequency and field strength on the viscosity of such organic liquids as CCl_2H_2 and CH_3OCH_3 is determined. The results are analysed mathematically in terms of secondary effects such as heating and prevention of building up molecular complexes by ion motion. C. A. HOGARTH

532.13 : 532.7

5574. On the viscosity of fluids according to the kinetic theory. C. TRUESDELL. *Z. Phys.*, **131**, 273–89 (*No.* 3, 1952).

A critical discussion of the Stokes relation $3\lambda + 2\mu = 0$ and also of the dependence of μ on temperature. It is considered that the above relations are assumed rather than proved by the kinetic theory. T. C. TOYF

532.13 : 532.73

5575. Viscosity of dilute gelatin solutions. G. STAINSBY. Letter in *Nature* [*Lond.*] **169**, 662–3 (*April* 19, 1952).

The reduced viscosity of such solutions is measured

as a function of the pH and the concentration of added electrolyte at 35°. The addition of acid or alkali to an isoionic solution causes a net charge on the chains, which straightens them, but the forces between each charge pair are reduced. The addition of neutral salts also decreases these forces. A. J. TAYLOR

532.5

5576. On the calculation of dissipated energy. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belg. Cl. Sci.*, **37**, 1019–36 (*No.* 12, 1951) *In French.*

To describe the entropy balance of a fluid mixture it is necessary to add additional hypotheses to the conservation laws. Suitable hypotheses are suggested by analogy with the author's treatment of simple fluid systems (1948). The final formulae disagree with those of de Groot whose work is criticized on the following grounds: (*a*) de Groot fails to draw attention to the hypothetical nature of his initial equations; (*b*) even on his own hypotheses, de Groot's treatment of entropy flux and viscous dissipation is unsatisfactory. [This paper illustrates how little is known about the phenomenology of moving fluids.]

R. O. DAVIES

532.5

5577. Flow of fluid media with internal changes and volume viscosity. J. MEIXNER. *Z. Phys.*, **131**, 456–69 (*No.* 4, 1952) *In German.*

The necessary modification of the usual hydrodynamic equations, to allow for internal changes (relaxation processes, including certain chemical changes), is investigated. If the internal changes take place sufficiently rapidly compared with the flow processes, their effect will be apparent simply as a volume viscosity. This is put forward as the explanation of observed volume viscosities. It is shown how internal changes which are not rapid compared with the flow processes are influenced by other processes characterized by shorter relaxation times.

J. G. OLDROYD

532.51 : 535.515

5578. The use of doubly refracting solutions in the investigation of fluid flow phenomena. B. ROSENBERG. *Navy Dep., Taylor Model Basin Rep.* 617, 39 *pp.* (*March*, 1952).

The feasibility of using doubly refracting liquids for qualitative and quantitative flow studies is discussed. Colloidal solutions of bentonite are most suitable because of their high sensitivity, low viscosity, cheapness and comparative ease of preparation. The problems of preparation and use of bentonite solutions are considered. The effect on the double refracting properties of bentonite of such physical factors as concentration, particle size, ageing and preliminary treatment, and temperature are discussed. It is concluded that a 0·8% concentration with an equivalent spherical diameter of 50 mμ at a temperature of about 75°F is very suitable. Brief details are given of essential optical and photo-elastic theory and an optical arrangement suitable for hydrodynamic studies is recommended. A method of determining the velocity distribution and streamlines for two-dimensional laminar flow using either pure liquids or colloidal solutions is suggested. Pure liquids are less sensitive and more viscous than bentonite solutions. Because the adequacy of the hydrodynamic theory as applied to colloidal particles in two-dimensional flow is questionable a more detailed analysis is attempted. Once the velocity distribution and streamlines have been obtained, methods of obtaining the pressure distribution, viscous drag, and viscous lift are suggested. It is concluded that streaming birefringence will be applicable qualitatively to turbulent flow studies in two dimensions, particularly in boundary layer studies. Mention is made of its possible use for studying three-dimensional flow. H. G. JERRARD

532.51 : 538.12 : 538.3

5579. On the behaviour of an electrically conductive liquid in a magnetic field. B. LEHNERT. *Ark. Fys.*, **5**, 69–90 (*Paper* 5, 1952).

The velocity-distribution of a laminar motion in a conducting viscous liquid is strongly modified by the presence of an external magnetic field. The shape of the distribution depends on the linear dimensions. The transition between a laminar and non-laminar motion as well as the non-laminar motion itself are influenced by the field. A set of characteristic parameters, corresponding to Reynolds number, may be defined. A.

532.525

5580. The atomization of liquid in a flat spray. R. G. DORMAN. *Brit. J. Appl. Phys.*, **3**, 189–92 (*June*, 1952).

The drop-size distribution in flat sprays produced by agricultural nozzles is discussed and an equation has been derived by dimensional analysis relating a mean drop diameter to operating conditions at the nozzle. The equation has been applied to experimental data for agricultural nozzles with satisfactory results. The development of the spray sheet with pressure increase is shown by high-speed photographs.

A.

532.528 : 534.321.9

5581. Methods for the investigation of vibration cavitation in fluids with ultrasonic waves. T. LANGE. *Akust. Beih., No.* 2, AB75–AB82 (1952) *In German.*

A high intensity sonic field is generated in water by means of a quartz crystal (300; 575; 800 kc/s). Cavitation sets in at the nucleus bubbles, which oscillate non-linearly, and their sound radiation causes noise, measured by a hydrophone. The critical point at which cavitation commences is determined in the following ways: (1) From the discontinuity in the curve of microphone voltage (transmitting frequency) *v.* transmitter voltage. (2) From the observed formation of bubbles. (3) From the commencement of a high-frequency noise, which is analysed from 60 to 1100 kc/s. (4) From the commencement of low-frequency noise, in which case the hydrophone can be at the same time employed for measuring the radiation pressure for amplitude-modulated ultrasonic radiation. (5) From the formation of peaks of high pressure, which can be visually demonstrated using a wide-band amplifier and an oscillograph. The important influence of the size of the nuclei on the tensile strength and on the onset of cavitation is experimentally determined. A.

532.57

5582. Contribution to the method of measuring fluid velocities. H. ZELLER. *Diss. E.T.H. Zürich, No.* 2023, 57 *pp.* (1951) *In German.*

Using a half cell, probe and flowing electrolyte, the current-voltage curve is recorded with a polarograph and the current maxima are shown to be related to the velocity of the electrolyte. The velocity is also measured using a hot wire probe. J. E. CAFFYN

532.57 : 578

5583. Improved apparatus and technique for electromagnetic determination of blood flow. A. KOLIN. *Rev. Sci. Instrum.*, **23**, 235–42 (*May*, 1952).

Describes improvements in the method of measuring blood flow by electromagnetic induction in intact blood vessels left in their normal place. "Pick-up sleeves" and "occlusion cuffs" are described which can be implanted permanently into the animal without causing irritation. A method of finding the optimum position of the blood vessel in the magnetic field and of determining the strength of the utilized magnetic field component is outlined. It is shown that calibration of individual blood vessels is unnecessary; a given apparatus is calibrated once and for all by one single flow measurement *in vitro*. The design of the compensator is simplified. A method for compensating disturbances encountered with blood vessels which are agitated in the magnetic field is described. Various sources of electromagnetic disturbances and means of eliminating them are discussed. A.

532.59

5584. The theory of symmetrical gravity waves of finite amplitude. II. The solitary wave. B. A. PACKHAM. *Proc. Roy. Soc. A*, **213**, 238–49 (*June* 24, 1952).

For Pt I, see Abstr. 8554 (1951). An exact solution is obtained to a problem which differs from the two-dimensional problem of the solitary wave only in that the non-linear condition on the free surface is replaced by a slightly modified non-linear boundary condition having the same qualitative behaviour. Expressions are obtained for the wave velocity and amplitude, and also the equation of the free surface in parametric form. Breaking conditions at the crest are also investigated. A.

532.59

5585. Gravity waves of finite amplitude. III. Steady, symmetrical, periodic waves in a channel of finite depth. T. V. DAVIES. *Quart. Appl. Math.*, **10**, 57–67 (*April*, 1952).

CAPILLARITY 532.6

532.612 : 530.162

5586. A statistical-mechanical theory of surface tension. A. G. MACLELLAN. *Proc. Roy. Soc. A*, **213**, 274–84 (*June* 24, 1952).

A system is studied which consists of a large number of molecules contained in a rectangular parallelepiped with rigid walls. Volume and surface area are taken as two principal co-ordinates, and pressure and surface tension are considered as isothermal derivatives of the free energy. It is shown that, for a one-phase system, the thermodynamic pressure so obtained depends on the values, at the centre of the container, of the number density and the pair-distribution function. Two types of surface tension are considered as derivatives of the free energy, that at the walls of the container and that at the surface between liquid and vapour. For the latter, the formula obtained agrees with that of Kirkwood and Buff (1949), who treated surface tension from the point of view of a stress, and it is shown how their treatment may be shortened considerably. The virial of the forces exerted by the container on the molecules is shown to include terms involving the surface tensions referred to above, and it is proved that the quantities, pressure and surface tensions, occurring in the expression of the Clausius virial theorem, agree with the corresponding thermodynamic quantities. For the tension of a plane surface between phases, an approximate formula is obtained which depends on a suggested approximate form for the pair-distribution function. A.

532.613 : 536.7

5587. The condition for the creeping of a liquid past a mercury seal. R. S. JESSUP. *J. Appl. Phys.*, **23**, 543–5 (*May*, 1952).

An observation of the creeping of a liquid past a Hg seal is reported. The conditions under which such a phenomenon might be expected to occur are discussed in terms of the thermodynamics of surfaces. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

5588. On the kinetic theory of self diffusion and the viscosity of liquids. K. ALTENBURG. *Z. phys. Chem.*, **199**, 69–89 (*Jan.*, 1952) *In German.*

Using a simple liquid model the number of collisions and also the activation energy is shown to depend on temperature and the temperature dependence of both self diffusion and viscosity are derived. T. C. TOYE

532.72

5589. Concentration-dependence of the rate of diffusion of polystyrol in a solution. V. N. TSVETKOV AND S. P. KROZER. *Dokl. Akad. Nauk SSSR*, **81**, 383–6 (*No.* 3, 1951) *In Russian.*

532.72 : 535.412

The use of interference fringes for measurement of diffusion coefficients. *See Abstr.* 5694

532.77 : 534.39

5590. On the action of transverse ultrasonic waves in solutions of rigid high polymers. R. CERF. *C.R. Acad. Sci.* [*Paris*] **234**, 1549–51 (*April* 7, 1952) *In French.*

Previous work on specific viscosity and relaxation times for flexible molecules [Abstr. 1524 (1952)] is now used for rigid molecules. T. C. TOYE

MECHANICS OF GASES 533

533.15

5591. Sorption and surface diffusion in porous glass. R. M. BARRER AND J. A. BARRIE. *Proc. Roy. Soc. A*, **213**, 250–65 (*June* 24, 1952).

Sorption, gas-phase diffusion in the region of molecular streaming, and surface diffusion in very dilute adsorbed films have been studied quantitatively for a number of gases in membranes of porous glass. The sorption of O, N, A, SO_2 and NH_3 near their liquefying temperatures resulted in type IV isotherms with very characteristic hysteresis loops. From the isotherms porosity, surface area and mean pore radius were evaluated. Heats of sorption, ΔH, have been obtained in very dilute adsorbed films and in films where v/v_m approaches or exceeds 1. These heats showed the porous glass to be an energetically non-uniform sorbing surface. The Henry's law region of sorption was studied and Henry's law sorption constants evaluated at 273, 290, 323 and 343°K for the most dilute adsorbed films of O, N, A, Kr, CH_4 and C_2H_6. Nearly all this information is essential for measurements of surface diffusion by the transient state method of Barrer and Grove (1951). The micropore structure was so fine that non-sorbed gases diffused within the porous glass only by molecular streaming at pressures up to half an atmosphere or more. Effects of sorption upon this diffusion were inappreciable for He, Ne and possibly H; for O, N, A, Kr, CH_4 and C_2H_6 the influence of sorption upon time-lags and diffusion coefficients became progressively more marked. In the steady state of flow there was little evidence of surface diffusion when, in the most dilute adsorbed films, Henry's law is obeyed. On the other hand, in the transient state of flow, surface diffusion makes a substantial contribution to flow. Reasons are given for the difference in the extent to which surface mobility can be detected in the two states of flow. Consistent values of the surface diffusion coefficients, D_s, were obtained for O, N, A, Kr, CH_4 and C_2H_6. These values of D_s were compatible with the Arrhenius equation $D_s = D_0 \exp(-E/RT)$ over the temperature range of 273 to 343°K investigated. The ratio of E to ΔH for very dilute adsorbed films lay between 0·5 and 0·6, and should in order of magnitude be characteristic of a heterogeneous sorbing surface. The numerical values of D_s have been compared with D for liquids, and analysed in terms of entropy and energy of activation. A.

533.15 : 536.48

5592. Diffusion in gaseous helium at low temperatures. R. A. BUCKINGHAM AND R. A. SCRIVEN. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 376–7 (*May*, 1952).

Reports calculations on the diffusion coefficient and thermal diffusion ratio in He^3–He^4 mixtures at 5°K and below. R. B. DINGLE

533.275

5593. Dew-point determination by visible wetting. R. H. BUCHANAN, A. R. KING AND R. H. SATTERLY. *Aust. J. Appl. Sci.*, **3**, 14–15 (*March*, 1952).

It is difficult to measure the dewpoint of a hydrophobic solvent-air mixture, since the condensate wets the metal mirror in the conventional apparatus, and the resulting transparent liquid film produces negligible change in reflectivity. A method is presented where marked change in reflectivity occurs when a hydrophobic solvent wets a specially prepared hydrophobic surface. The grey velvet-like copper sulphide matte in the described apparatus is instantly transformed to a glossy black when minute quantities of a hydrophobic solvent condense on it, permitting dew-point reproducibility and sensitivity within ± 0·2°C. A.

533.5

5594. A straight-through vacuum valve. A. GILLES AND P. JOHANNIN. Letter in *J. Phys. Radium*, **13**, 109 (*Feb.*, 1952) *In French.*

This was used successfully in isolating the two sections of an absorptiometer in the Schumann region of the ultraviolet. It is mechanically simple and of small size. For a path of 20 mm its thickness is 45 mm, which can easily be cut to 20 mm. G. WITTENBERG

533.5 : 531.787 : 541.183

5595. The measurement of the lowest pressures below 10^{-7} torr by means of an adsorption manometer. M. SEDDIG AND G. HAASE. *Z. angew. Phys.*, **4**, 105–8 (*No.* 3, 1952) *In German.*

The variation of the electronic work function, ϕ, with time, measured photoelectrically by the method of Fowler (1931), for a clean heat-treated W surface, is used as the pressure indicator. ϕ rises linearly from 4·50 to 4·57 V approx. in 26 min. The experimental apparatus and procedure is described in some detail. S. WEINTROUB

533.54

5596. Investigation on the operation of the water jet pump. R. F. SIMONIN. *J. Phys. Radium*, **13**, 71A–72A (*Feb. Suppl.*, 1952) *In French.*

During evacuation, a transient state, not subject to Bernouilli's law, exists in the water jet. Volume of gas pumped depends on the number and size of bubbles ejected which, in turn, are governed by the surface tension of water and the surface area of the jet. The formation of hemispherical gas bubbles was observed by high-speed photography, and is explained in detail by mathematical analysis. G. WITTENBERG

533.6.011

5597. Measurement of the vibrational relaxation effect in CO_2 by means of shock tube interferograms. E. F. SMILEY, E. H. WINKLER AND Z. I. SLAWSKY. Letter in *J. Chem. Phys.*, **20**, 924 (*May*, 1952).

The relaxation region behind plane shock waves has been measured with peak temperatures of 900°K. Density ratios ahead and after shock agree with those calculated from thermodynamic data. J. JACOBS

533.6.011.3 : 534.231

5598. Second order acoustic fields: streaming with viscosity and relaxation. J. J. MARKHAM. *Phys. Rev.*, **86**, 497–502 (*May* 15, 1952).

The streaming caused by an acoustic field, which has been previously considered by Eckart, is re-examined. The concept of mass flow is introduced, and a relaxational relation between the excess pressure and the excess density is employed. Various proofs

f Eckart are modified. The results are essentially he same as those given by Eckart except that they pply to the mass flow instead of the particle velocity. lso, an explicit frequency dependence of the flow is btained which explains Liebermann's result in thyl formate. In general to have an average mass low, viscosity is needed, and the time average of the roduct of the density and the particle velocity, to econd order, is solenoidal. The proof regarding mass low is not sufficiently general to preclude the possiility of flow under every acoustic field. A.

533.6.08

5599. On the non-linear theory of the hot-wire anemometer. A. MUGGIA AND W. C. VAN 'T SANT. *Proc. K. Ned. Akad. Wet. B*, **55**, 130–3 (*No.* 2, 1952).

The non-linear term of the equations for the static heat loss of a hot wire is examined. The difference between platinum and tungsten wires as to non-linearity is studied and some experimental results are given concerning tungsten and platinum wires. A.

533.6.08

5600. Characteristics of a thermocouple anemometer. S. KAWATA, Y. ŌMORI AND K. NISHIMURA. *Mem. Fac. Engng Kyoto Univ.*, **14**, 12–20 (*Jan.*, 1952).

See Abstr. 9336 (1951). The construction, method of calibration and results of tests of nichrome hot-wire chromel-alumel thermocouple anemometers are described. Two forms of apparatus, one sucking in air by a vacuum pump for horizontal air streams of speeds less than 90 cm/sec and the other using a propellor for 1–8 m/sec, were used. The results are shown graphically and discussed in relation to the formula $i^2 = kE(A + Bv^{\frac{1}{2}})$ where i is the heater current, E is the e.m.f. produced in the thermocouple and v the air-stream speed. S. WEINTROUB

533.6.08 : 537.562

5601. An ionization current anemometer, using radioactivity. W. FUCKS. *Z. angew. Phys.*, **4**, 51–3 (*No.* 2, 1952) *In German.*

Describes a method for measuring air flow velocities by observations of the current passing between two electrodes, suitably arranged with respect to the air stream and activated by means of a radioactive material. J. D. CRAGGS

MOLECULAR THEORY OF GASES 533.7

533.75 : 536.71

5602. An equation of state applicable to gases at densities near that of the solid and temperatures far above the critical. T. L. COTTRELL AND S. PATERSON. *Proc. Roy. Soc. A*, **213**, 214–25 (*June* 24, 1952).

It is suggested that, at high pressures and temperatures far above the critical, the intermolecular interaction is predominantly repulsive. The effect on a molecule of its neighbours is therefore replaced by an infinitely steep potential well of volume related to the molecular volume. This concept is used to write down the equation of state for such a gas. It is shown that this equation is likely to hold in the range of density and temperature characteristic of the detonation wave in condensed explosives. The equations of the hydrodynamic theory of detonation are developed in terms of this equation of state, and applied to pentaerythritol tetranitrate. The calculated dependence of detonation velocity on loading density is in very good agreement with experiment; the temperature shows a sharp decrease with increased loading density. This is a consequence of the intermolecular repulsive energy characteristic of the model chosen. A.

533.75 : 536.71

5603. On the cell method and the theory of imperfect gases. A. CHWOLES-ENGLERT. Letter in *J. Chem. Phys.*, **20**, 925–6 (*May*, 1952).

Janssens and Prigogine have suggested a modification of the ordinary cell method for the evaluation of configurational free energy in which each cell contains 0, 1 or 2 particles. Their results are now extended, using the same method, to calculate the configurational energy of perfect gases assuming each cell to be occupied by 0, 1, 2 or 3 particles simultaneously. Confirmation is obtained that a cell method which takes account of the increasing fluctuations of particle density, when large volumes are concerned, leads to the same results as the classical theory of perfect gases. Curves are given of the free energy as a function of density calculated by different methods. The modifications in the equation of state of imperfect gases introduced by the assumption of fluctuations of particle density in the cell model are investigated. It is concluded that cell methods based on the conception of the average field are unable to represent the equation of state even if account is taken of the fluctuation of particle density in the gas. Similarly the equation of state in the critical region is not improved. F. E. HOARE

533.75 : 536.71 : 541.124

5604. Equation of state of gases at high temperature. H. M. PEEK AND Z. W. SALSBURG. Letter in *J. Chem. Phys.*, **20**, 763 (*April*, 1952).

Since a knowledge of the detonation velocity as a function of the initial density is insufficient to determine the equation of state of the product gases, it becomes important to know what other variables should be determined to yield the equation of state. It is shown that a knowledge of the density or pressure at the Chapman–Jouguet plane is theoretically sufficient for this. The experimental requirements of such determinations are discussed. Such investigations would provide useful thermodynamic data at high temperatures and pressures and might give information concerning the kinetics of the detonation process. F. E. HOARE

VIBRATIONS . ACOUSTICS 534

534.014.5

5605. Remarks on the application of the matrix calculus to systems with linear and semi-linear reaction. J. SALMON. *J. Phys. Radium*, **13**, 25A–28A (*Feb. Suppl.*, 1952) *In French.*

The condition for the initiation of oscillations in a

linear system is written down (unity must be a latent root of a certain matrix). The result is extended to certain non-linear systems. L. S. GODDARD

534.113

5606. Transverse vibrations of uniform thin bars. R. HELLER. *J. Acoust. Soc. Amer.*, **24**, 273–5 (*May*, 1952).

Continuing the theoretical work of Strehlke, Seebeck and Lord Rayleigh, the transverse vibrations of uniform thin bars subject to the following end conditions are considered: (*a*) both ends free; (*b*) both ends fixed; (*c*) one end free, the other fixed. Accurate values for the position of the nodes, antinodes and points of inflection and of maximum curvature are calculated for the first few principal modes of vibration, several errors of long standing are rectified and the amplitudes at the antinodes are computed. Approximate expressions, valid for the modes of higher order, are given for the node and antinode positions as well as for the amplitudes at the antinodes. A.

534.115 : 550.346

5607. A study on the damping of longitudinal vibration of an elastic cylinder. T. SUHARA. *Rep. Res. Inst. Elast. Engng*, **7**, 25–38 (*No.* 3, *March*, 1951).

The longitudinal vibration of an elastic cylinder ideally welded at its lower end to a semi-infinite elastic body is mathematically investigated. The decay of vibration, due to energy flow through the junction into the elastic system in the form of divergent elastic waves, is calculated and shown to be the decisive factor in damping of the vibration of a tower caused by an earthquake. A. GELBTUCH

534.121.2

5608. Statics and dynamics of rigid membranes. H. PAILLOUX. *C.R. Acad. Sci.* [*Paris*] **234**, 1430–2 (*March* 31, 1952) *In French.*

The general expression for the potential energy of bending of an elastic shell is written down, and its approximate form in terms of the parameters of the middle surface is discussed. A method of investigating normal modes of vibration by solving Lagrangian equations of motion is indicated. J. G. OLDROYD

534.121.3

5609. A general bell-formula. A. LEHR. *Acustica*, **2**, 35–8 (*No.* 1, 1952).

Similarity rules of bells are discussed. Although a set of carillon bells is never similarly shaped throughout, a simple relation between mass, dimension and frequency still holds. This amounts to the statement that the frequency of a bell is proportional to its average thickness, a relation known from, e.g., transverse vibrations of bars, plates and hollow cylinders. A.

534.131

5610. Methods for approximate calculation of eigenvalues of elastic vibrations of anisotropic bodies. H. J. MÄHLY. *Diss. E.T.H. Zürich, No.* 1605, 42 *pp.* (1951) *In German.*

The Ritz and the perturbation methods are considered in detail; the iteration and Grammel's methods, not applicable to the problem of crystal vibrations, are briefly described. Temple's and Weinstein's theorems are extended and new theorems are deduced for finding the lower and upper limits of the eigenvalues. Twenty-six references. A. GELBTUCH

534.141.3

5611. Investigation on the bowed string with an electrically driven bow. I. K. C. KAR, N. K. DATTA AND S. K. GHOSH. *Indian J. Phys.*, **25**, 423–32 (*Sept.*, 1951).

The paper describes the construction of a new electrically bowed violin with very sensitive arrangements for measuring bowing pressure and velocity. Experiment is carried on to study the relation between minimum bowing pressure P_{min} to elicit a steady fundamental tone, and distance d of the bowed region. Keeping the distance d fixed, the relation between minimum bowing pressure P_{min} and the bowing velocity V is studied thoroughly at two different frequencies, and also the effect of change of the vibrating length of the string in P_{min}-V curves. A full theoretical interpretation of the curves has been given for the first time. A.

534.141.4 : 532.528

5612. The production of liquid vortex tones, and some associated phenomena. F. L. HOPWOOD. *Acustica*, **2**, 39–44 (*No.* 1, 1952).

An account is given of the production of liquid vortex tones when perforated disks or hollow cylinders are rotated under water or kerosene. The tones produced are discontinuous, and their pitch may rise or fall as the rotor speed is increased. The effect of baffles on increasing or decreasing the loudness of the tones is described. A stream of gas bubbles near a perforated rotor may increase the loudness of its vortex tones very considerably—an effect attributed to resonance and the diminution of the acoustic wave impedance of the medium. Illustrations are given of the surprising behaviour and beautiful appearance of the jets and fountains produced by a perforated or slotted disk when it is rotated a little below a water surface. Some implications of the bearing of the phenomena on propeller erosion and submarine detection are mentioned. The need is emphasized for further experimental data. A.

534.222

5613. The velocity of sound in a real gas as function of the pressure. N. PUSAT. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **17**, 46–60 (*No.* 1, 1952).

The formula for the velocity of sound in a real gas which shows a relaxation-mechanism was calculated as function of pressure and frequency. This formula has been discussed specially for CO_2. The velocity of sound in the vapour of ethyl-formate was measured with an acoustical interferometer. The theoretical conclusions have been applied to the results. A mechanism of relaxation was found with a characteristic time constant of $1{\cdot}9\times10^{-8}$ sec, calculated for 1 atm. pressure. A.

534.222

5614. Ultrasonic velocity in liquids and liquid mixtures. B. JACOBSON. Letter in *J. Chem. Phys.*, **20**, 927–8 (*May*, 1952).

An empirical relation between the ultrasonic

velocity in a liquid and the free length between molecular surfaces is derived. It is also shown that no simple relation is possible between the velocity of sound and chemical constitution. T. C. TOYE

534.22 : 538.6

5615. Magnetically induced ultrasonic velocity changes in polycrystalline nickel. S. J. JOHNSON AND T. F. ROGERS. *J. Appl. Phys.*, **23**, 574–7 (*May*, 1952).

Measurements of magnetically induced velocity changes in polycrystalline Ni rods are discussed. Shear and compressional ultrasonic propagation modes are used throughout the frequency range of 1–10 Mc/s. The polycrystalline measurements are compared to recently published single Ni crystal values. The ΔE effect is found to decrease with increasing frequency throughout the megacycle region, showing general agreement with low-frequency measurements. A.

534.222.2

5616. Transmission of shock waves in thinwalled cylindrical tubes. F. I. N. NIORDSON. *K. Tekn. Högsk. Handl.*, *No.* 57, 20 *pp.* (1952).

The deformation of an infinitely long thin-walled cylindrical tube is computed, due to a shock wave in the medium inside the tube, and it is established that the deformation becomes considerable when the velocity of the shock wave is close to, but above, a certain critical velocity of the tube. The elastic and kinetic energy in the walls of the tube due to the deformation is also computed, and the hydrodynamical aspects of the problem are treated. The usual jump conditions of the shock front are modified so as to take into account the consumption of energy in the walls. It is found that the relation between the particle- and the shock velocity is not a one-to-one relation, and that a shock wave cannot travel above and arbitrarily close to the critical velocity of the tube. The last section deals with the effects of a discontinuity of the thickness of the walls. A shock wave moving in a rigid tube and entering a thin-walled tube of the same inner diameter is retarded while the particles are accelerated and the pressure behind the front decreases. The changes may be considerable if the shock front has originally a velocity in a certain interval above the critical velocity of the tube. A.

534.23

5617. The transmission of waves through plates. A. SCHOCH. *Acustica*, **2**, 1–17 (*No.* 1, 1952) *In German.*

The theory of transmission of sound—plane waves and laterally bounded beams—through plates is given in a form which reveals the connection with the free waves in plates. Cremer's interpretation of total transmission as "coincidence" of the incident wave with a free wave in the plate, certain exceptions from that representation, and the influence of the finite cross-section of the beam are discussed. The conclusions have been examined experimentally on aluminium plates by ultrasonic waves. A.

543.23

5618. Ultrasonic absorption in normal air at 456 kc/s for different humidities. GOPALJI. *Indian J. Phys.*, **25**, 298–304 (*June*, 1951).

A simpler treatment of the ultrasonic absorption formula $\mu = 2{\cdot}303\,[\log_{10}\Delta\theta_A - \log_{10}\Delta\theta_B]/(n_B - n_A)$ is presented. A stable and sensitive Pierce interferometer has been used to measure ultrasonic absorption in normal air at 455·8 kc/s for different humidities. The special features of the work are the use of a proper crystal mounting and the use of a large volume humidity cabinet in which the interferometer was placed. It is found that the absorption curve shows a peak at about 48% humidity for the frequency used in the work. A.

534.23

5619. Investigations on ultrasonic absorption in animal tissues and plastics. R. ESCHE. *Akust. Beih.*, *No.* 2, AB71–AB74 (1952) *In German.*

Measurements in the frequency-range 300–600 kc/s prove the absorption coefficient to increase linearly with frequency. They agree well with results obtained by other authors at higher frequencies. A.

534.23 : 621.315.62 : 620.179.16

5620. Non-destructive testing of ceramic insulators by ultrasound. H. BARTHELT AND A. LUTSCH. *Siemens Z.*, **26**, 114–21 (*April*, 1952) *In German.*

Frequencies of 1, 2·5 and 5 Mc/s have been used to detect flaws in ceramic insulators by the echo method. Measurements of the velocity of ultrasound showed that an under-fired porcelain gave velocities from $4{\cdot}3$ to $4{\cdot}9\times10^5$ cm/sec, over-fired material gave values between $4{\cdot}8$ and 5×10^5 cm/sec, while correctly prepared material gave values of $5{\cdot}1$ and $5{\cdot}34\times10^5$ cm/sec, thus affording a method of checking the quality of the firing. As would be expected, absorption measurements showed that minimum absorption occurred with the correctly fired material at all three testing frequencies, the most marked minimum occurring at 5 Mc/s. A. C. WHIFFIN (R)

534.231

5621. Second-order acoustic fields: relations between density and pressure. J. J. MARKHAM. *Phys. Rev.*, **86**, 710–11 (*June* 1, 1952).

In acoustics the relations between the excess pressure and the excess density neglect effects of the fluid flow. The object of this paper is to derive a general relation between the pressure and density which includes streaming. This is done for a non-absorbing ideal fluid from general thermodynamic arguments. The results justified the static derivations (neglecting flow terms) which are used for more complex media. A.

534.231

5622. Second-order acoustic fields. Energy relations. J. J. MARKHAM. *Phys. Rev.*, **86**, 712–14 (*June* 1, 1952).

The expression for the potential energy stored in an acoustic field is examined. Two corrections to the accepted results are found. These corrections are small for a liquid but of major importance for a gas. Indeed, to obtain the average stored acoustic energy for a gas, it is necessary to have more exact solutions than are usually used. Thermodynamic arguments are made to show the meaning of the corrections introduced into the expression for the stored energy. A.

534.232

5623. A more rapidly-convergent expansion for the velocity potential of a piston source. H. ELROD, JR. Letter in *J. Acoust. Soc. Amer.*, **24**, 325–6 (*May*, 1952).

This new variation of the Carter and Williams expansion is especially useful for calculations in the paraxial regions, where it shows the terms neglected by earlier approximate formulae. A.

534.232 : 538.652

5624. Critical consideration of the linear magnetostrictive ultrasonic generator using dumb-bell-shaped oscillators. H. H. RUST AND E. BAILITIS. *Akust. Beih., No.* 2, AB89–AB90 (1952) *In German.*

It is shown that the transverse magnetostrictive effect acts oppressively upon the resulting amplitude of longitudinal magnetostrictive oscillators of the dumb-bell type. With transducers of conventional size using nickel as ferromagnetic material the out-of-resonance amplitude is less than half that value which can be obtained from the magnetostriction curve, the loss of amplitude due to remanence being taken into account. A.

534.24

5625. Lateral displacement of a totally-reflected ultrasonic ray. A. SCHOCH. *Acustica*, **2**, 18–19 (*No.* 1, 1952) *In German.*

A beam of sound undergoes a relatively large lateral displacement at reflection from a solid surface, if such an angle of incidence is chosen that a Rayleigh wave is excited in the solid medium. A.

534.24

5626. Reflection of a pulse by a concave paraboloid. D. V. ANDERSON. Letter in *J. Acoust. Soc. Amer.*, **24**, 324–5 (*May*, 1952).

For the special case of a rectangular pulse Friedlander has computed the variation of amplitude of the pulse reflected from a concave paraboloid, with the distance from the axis. These calculations indicated that, in addition to the maximum on the axis, a secondary pressure maximum is to be found at a distance of approximately 0·75 times the focal length from the axis. The author has observed this phenomenon experimentally using a pulse frequency of 180 kc/s and a repetition rate of 100 c/s.

A. B. WOOD

534.26

5627. Diffraction of sound waves at the circular aperture in an opaque screen. H. SEVERIN AND C. STARKE. *Akust. Beih., No.* 2, AB59–AB66 (1952) *In German.*

The sound pressure at the central normal behind circular apertures in rigid screens of radii $\rho_0 = 0{\cdot}5\lambda$, 1λ, $1{\cdot}5\lambda$, 2λ, 3λ and 4λ, and within the plane of the screens was experimentally investigated. An application of the Kirchhoff theory to these problems supplies two approximate solutions. These are compared with the experimental results, and it is shown that the observed diffraction effects down to a diaphragm radius of $\lambda/2$ can be fairly well explained, within the limits of the accuracy of measurements, using the velocity potential derived from the area of the aperture considered to be covered with dipoles. A.

534.26

5628. On acoustic diffraction cross sections for oblique incidence. J. W. MILES. Letter in *J. Acoust. Soc. Amer.*, **24**, 324–5 (*May*, 1952).

Reference is made to a previous paper by the author [Abstr. 6040 (1949)] in which the approximate treatment of diffraction problems, using Schwinger's variational methods, has been discussed. The present paper shows that the variational formulation furnishes a convenient method for relating the plane wave transmission cross-section of an aperture for oblique incidence to that for normal incidence. A. B. WOOD

534.26 : 535.42

Intensity expressions for the diffraction of light by an amplitude modulated ultrasonic beam. *See Abstr.* 5701

534.321.4

5629. Concerning the frequencies resulting from distortion. H. N. MAXWELL. Letter in *Amer. J. Phys.*, **20**, 310–11 (*May*, 1952).

When a monochromatic train of waves is distorted in some fashion, additional frequencies appear. While the appearance of these frequencies can be explained mathematically by Fourier's series, the author queries the physical explanation of their origin. R. W. FISH

534.37

5630. Supplement to "Damping in acoustic resonators." K. VOELZ. *Z. angew. Phys.*, **4**, 18–19 (*No.* 1, 1952) *In German.*

See Abstr. 6812 (1951). Heat boundary layer is discussed and the method of calculation of losses therein shown by means of a simple example. Reference is also made to the damping in the outer surfaces of a cylinder. W. W. GEHR

534.372

5631. The thermal damping of elastic vibrations. E. SCHREUER. *Z. Phys.*, **131**, 619–28 (*No.* 4, 1952) *In German.*

The logarithmic decrement is calculated, which corresponds to energy dissipation due to the cycle of changes in an oscillating elastic solid being not strictly adiabatic, temperature differences between neighbouring points tending to level themselves out spontaneously. A specimen subjected to tensile or isotropic stress is considered. The shape of the curve relating logarithmic decrement with frequency is then dependent only on the amplitude of stress variations, not on the physical constants of the material. Reasonable agreement with available experimental results is demonstrated. J. G. OLDROYD

534.39

5632. Observations on oil fountains produced by ultrasonics. F. SEIDL. *Acustica*, **2**, 45–7 (*No.* 1, 1952) *In German.*

534.41

5633. Detection and analysis of insect noises. W. LOTTERMOSER. *Akust. Beih., No.* 2, AB66–AB71 (1952) *In German.*

An apparatus is described. Some oscillograms and spectra of sound produced by crickets and grasshoppers are presented. A.

534.612.4

5634. An absolute method of calibration of microphones at audible and ultrasonic frequencies. V. Gavreau, M. Dratz and A. Calaora. *C.R. Acad. Sci.* [*Paris*] **234,** 1603–5 (*April* 16, 1952) *In French.*

A pistonphone comprising a duralumin cylinder mounted in rubber is used as a sound source up to 40 kc/s. The amplitude of vibration of its surface is measured by an optical system using the polished surface of the piston as a mirror. Specimen calibration results at 9·45 and 37·8 kc/s are given.

G. F. HODSMAN

534.62

5635. Wide-band absorber for sound waves in liquids. E. Meyer and K. Tamm. *Akust. Beih., No.* 2, AB91–AB104 (1952) *In German.*

A new wide-band absorber for water-borne sound to line measuring tanks is investigated experimentally and theoretically. The frequency range is 5 to 50 kc/s. It consists of rubber-elastic materials the after-effect of which is used for the energy absorption and which are made more compressible than rubber or water by making them porous or by inserting larger holes. Parallel ribs of the material form parallel ducts, in which the sound energy is absorbed; to match the characteristic impedance of the medium and the absorber the duct walls are wedge-shaped at their exposed sides. A.

534.62

5636. Investigations on improving the lining of sound-absorbing chambers. G. Kurtze. *Akust. Beih., No.* 2, AB104–AB107 (1952) *In German.*

The paper shows how to improve the sound absorption of absorbing wedges as used in anechoic chambers by means of resonators of the Helmholtz-type arranged behind. The resulting arrangement has the same absorption coefficient with only $\frac{2}{3}$ of the depth of the usual wedges. A.

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 6233

534.843

5637. The correlation coefficient as a criterion of the acoustical quality of a closed room. S. G. Gershman. *Zh. Tekh. Fiz.*, **21,** 1492–6 (*No.* 12, 1951) *In Russian.*

A preliminary account of a theoretical and experimental study. The dependence of the auto-correlation function R on the time interval of correlation is represented by curves of calculated and measured values, for several different audio-frequency bands, in a non-reverberant room. Comparison of values of R for these and for rooms with various degrees of reverberation, and sounds with various directional properties and frequency spectra, indicate that in determining the sound quality of a room, R is a more sensitive parameter than the reverberation time, since R to a greater extent characterizes the sound process at a given point. F. QUELON

534.846.4

5638. Improvement of the acoustics of a theatre by a time-delayed local speaker arrangement. G. R. Schodder, F.-K. Schröder and R. Thiele. *Akust. Beih., No.* 2, AB115–AB116 (1952) *In German.*

535.214.6

5639. Experiments and notes on photophoresis. T.-T. Ouang. *C.R. Acad. Sci.* [*Paris*] **234,** 1542–4 (*April* 7, 1952) *In French.*

A differential torsional pendulum was used to determine the sign of the temperature difference between the front and back faces of small particles exposed to visible light. The front face was found to be the hotter, thus showing that negative photophoresis cannot be due to a greater absorption of energy by the face remote from the light.

N. CORCORAN

535.247.4

5640. Physical photometry in the Purkinje range. W. S. Plymale, Jr, and G. T. Hicks. *J. Opt. Soc. Amer.*, **42,** 344–8 (*May*, 1952).

The problem of obtaining accurate photometric data at brightness levels below 0·5 foot-lambert is reviewed briefly. A method of calibrating a photoelectric photometer for heterochromatic measurements in this so-called Purkinje range is described with some details given of the design of the instrument used. By arbitrarily dividing the luminous emission of a W lamp into 12 overlapping spectral bands it has been possible to calibrate a photometer, using a single correction filter for the phototube. The practical advantages of such a calibration include much time saved in brightness measurements on phosphor samples of different colours. A.

535.247.4

5641. An objective method for measuring the daylight factor. W. Koch and D. Kaplan. *J. Sci. Instrum.*, **29,** 179–80 (*June*, 1952).

Daylight factors are measured by connecting two photocells in a bridge-circuit. Provisions are made in the instrument described to minimize errors due to: (*a*) deviation from the cosine law for incident light; (*b*) disparity between the sensitivity of the photocell and that of the human eye; (*c*) heating-up of the photocell in sunlight; (*d*) improper levelling of the photocell. Only one observer is needed for the measurements. A.

535.247.4 : 535.14

5642. The fundamental limit of sensitivity of photometers. R. Wilson. *Rev. Sci. Instrum.*, **23,** 217–23 (*May*, 1952).

The general problem of the statistical fluctuations in the detection of light quanta by photocells is considered. The various methods of detection of the photoelectric current are compared and the extent to which each method approaches the limiting sensitivity is discussed. It is shown that light intensities of the order of 1 quantum per second can be detected with present apparatus. A.

535.314

5643. Features of refraction by a semi-plane. W. Braunbek and G. Laukien. *Optik*, **9,** 174–9 (*No.* 4, 1952) *In German.*

The theoretical study of refraction at a perfectly reflecting half-plane. Individual features of intensity phase distribution and flow of energy are discussed in

simplified mathematical form and the results are diagrammatically illustrated. The case treated is that in which the magnetic vector is parallel to the edge. The treatment is a development of Sommerfeld's method. The distribution of (1) lines of constant phase, (2) the energy distribution lines, (3) the lines of constant amplitude, are graphically plotted. The shadow space has a simple fall-off in intensity. The reflection-space shows a series of alternations and broad modulations. S. TOLANSKY

535.317

5644. The computation of the path of a ray and the correction of the aberrations of a lens system. I–II. T. SUZUKI. *Proc. Japan Acad.*, **27**, 179–87 (*April*, 1952).

Pt I describes the method of ray tracing using the length of the perpendicular from the centre of curvature to ray and the angle between this perpendicular and the optical axis. Formulae for sagittal and tangential rays, and a method of calculating the chromatic aberration are given. Pt II gives a differential method, based upon the formulae of Pt I, for varying the lens radii, etc., to give any desired state of correction. R. W. FISH

535.317.1

5645. A new method of measuring focal length. H. SCHULZ. *Optik*, **9**, 167–73 (*No.* 4, 1952) *In German.*

Three images of a slit are formed by the lens being measured, one directly and the others after reflection from two plane mirrors placed parallel and close to the optical axis. Measurement of the separations allows the focal length to be calculated from the known geometry. The method also yields information regarding the quality and flatness of the mirror surfaces and it can be modified for inspecting the finish of the inner surfaces of hollow cylinders. R. W. FISH

535.317.1

5646. Image error theory for finite aperture and field. M. HERZBERGER AND E. MARCHAND. *J. Opt. Soc. Amer.*, **42**, 306–21 (*May*, 1952).

An image error theory is developed for finite aperture and field. In the limit the formulae reduce to those of the well-known Seidel theory. The constants of the Seidel theory are replaced in the general theory by functions. It is shown that for a given object plane these functions can be reduced to two independent functions, the vanishing of one leading to a symmetrical image, the vanishing of both to a sharp image, and it also is proved that these two functions permit one to compute the caustic surfaces. The image error functions for a given plane can be identified as the 2nd-order derivatives of a characteristic function. To ascertain the image quality for a different plane, transformation formulae are developed which permit one to compute the 1st- and 2nd-order derivatives of this characteristic function for any shift of the object plane. The authors have found that the 2nd-order derivatives of another characteristic function are invariant with respect to a shift of the object and that a complete system of invariants of the image errors can be obtained. The basic formulae demonstrate that the shifted image-errors are linear functions of the image errors of the original plane and their 2nd- and 3rd-order determinants. Applications to classical problems are given. A

535.317.6

5647. Transfer and recursion formulae for the aberration coefficients of any given order in optical systems of spherical and plane surfaces. H. MARX. *Z. Phys.*, **131**, 408–19 (*No.* 3, 1952) *In German.*

A previous paper [Abstr. 931 (1951)] gave formulae from which the aberration coefficients of any order could be derived. As an extension, the entire transfer from surface to surface, and recursion, from order to order, computations can be carried out by the repeated application of four simple formulae. R. W. FISH

535.33.07

5648. A simple method for making very narrow slits. H. BURKHARDT AND H. MOSER. *Optik*, **9**, 163 (*No.* 4, 1952) *In German.*

Slits down to 1 μ in width and up to 1 cm in length can be made by laying threads of a semi-fluid material on a glass surface, evaporating silver over the entire surface and dissolving the thread away to form the slit. A semi-fluid thread yields a sharper edge than quartz or other solid fibres. R. W. FISH

535.33.07

5649. A simple rotating-cell double-beam unit for [single beam] spectrometers. J. D. S. GOULDEN AND S. S. RANDALL. Letter in *Nature* [*Lond.*] **169**, 748–9 (*May* 3, 1952).

Two absorption cells are rotated in front of the slit at 16 c/s so that the a.c. output is a function of the difference of intensity through the two cells. G. F. LOTHIAN

535.33.07–15

5650. "Ghost" bands in an infrared spectrometer. P. J. LAUNER. Letter in *J. Opt. Soc. Amer.*, **42**, 359–60 (*May*, 1952).

A deposit on NaCl near a Nernst glower gives bands near 7·4 and 12 μ attributed to $NaNO_3$. G. F. LOTHIAN

535.33.07–15

5651. Optical systems for increasing the available intensity from flames. E. K. PLYLER AND H. J. KOSTKOWSKI. Letter in *J. Opt. Soc. Amer.*, **42**, 360 (*May*, 1952).

A 3-mirror system admits 4 beams to an infra-red spectrometer. G. F. LOTHIAN

535.33.07–15

5652. Apparatus for conversion of infra-red spectrometer records to percentage transmission. R. A. G. CARRINGTON AND J. G. REYNOLDS. *J. Sci. Instrum.*, **29**, 197–9 (*June*, 1952).

The measurement and replotting as percentage transmission records of the two traces obtained when using single beam infrared recording spectrometers is time-consuming, taking at least as long as the actual production of the 2 traces by the spectrometer. An apparatus is described which enables these measurements and calculations to be made with considerable economy of time and labour. A

535.33.07–15 : 535.822.9

A reflecting microscope for infrared spectrometry. *See Abstr.* 5715

535.33.07–32

5653. Vacuum ultraviolet monochromator. P. D. JOHNSON. Letter in *J. Opt. Soc. Amer.*, **42**, 278–9 (*April*, 1952).

This note describes a simplified grating vacuum monochromator for use at wavelengths from 950 to 3 200 Å. The entire instrument is maintained at the proper pressure of hydrogen for operation of the hydrogen source. This obviates the necessity for having a diffusion vacuum pump and eliminates windows in the optical path. The application to absorption measurements of crystals is briefly described. R. W. FISH

535.331

5654. The first spark spectrum of manganese (Mn II). C. W. CURTIS. *J. Opt. Soc. Amer.*, **42**, 300–5 (*May*, 1952).

The analysis of the Mn II spectrum has been extended by the classification of approximately 600 additional lines. Most of the newly identified terms belong to the triplet system, for which no levels have previously been located. Intersystem lines have been found which fix the relative positions of the septet, quintet and triplet systems and all terms of these systems to be expected within 40 000 wave numbers of the ground state have been established. No singlet levels have as yet been located. A.

535.338.33 : 538.615

5655. Structure and Zeeman-effect in the spectrum of the tantalum atom Ta I. II. G. J. VAN DEN BERG, P. F. A. KLINKENBERG AND J. C. VAN DEN BOSCH. *Physica*, **18**, 221–48 (*April*, 1952).

For Pt I, see Abstr. 3430 (1951). The analysis of the Ta I-spectrum is continued. A few ground levels and a great number of high odd levels are found in addition to those given previously. Moreover, a group of high even levels is discovered from which the ionization potential is found to be $(7{\cdot}77 \pm 0{\cdot}10)$ V. The total number of classified Ta I-lines is now 1262, corresponding to transitions between 22 even ground levels, 182 odd levels and 8 high even levels. All newly classified lines and Zeeman-effect data are presented. The interpretation of the detected energy levels is revised and extended. Configuration calculations concerning the low even levels, using the method of Racah, are helpful in locating and interpreting a number of them. Typical perturbations are pointed out. A.

535.338.332

5656. Hyperfine structure of the spectra of gadolinium and zirconium. S. SUWA. Letter in *Phys. Rev.*, **86**, 247 (*April* 15, 1952).

535.338.332 : 539.152.2

5657. Hyperfine structure and nuclear moments of Xe^{129} and Xe^{131}. A. BOHR, J. KOCH AND E. RASMUSSEN. *Ark. Fys.*, **4**, 455–68 (*Paper* 29, 1952).

By means of an electromagnetic isotope separator, targets were prepared containing the odd xenon isotopes Xe^{129} and Xe^{131} in great purity. With these as electrodes in a Geissler tube, the infrared spectrum of Xe I was investigated with a Fabry–Perot interferometer. The h.f.s. of a number of lines were measured and the splittings of $1s$ and $2p$ terms determined. The data yield directly the ratio $\mu_{129}/\mu_{131} = -1{\cdot}131 \pm 0{\cdot}005$. From the deviations from the Landé interval rule, the quadrupole moment of Xe^{131} was estimated to be $-0{\cdot}12 \times 10^{-24}$ cm^2. In this estimate, use was made of the magnetic moment ratio to find term splittings which could not be directly measured. A theoretical analysis of the $1s$ and $2p$ terms of Xe I is made on the basis of the h.f.s. data. The results are compared with the information obtained from Zeeman effect and multiplet structure. A.

535.338.333 : 539.155.2

5658. The isotope displacement in the spectrum of Ba. H. KOPFERMANN AND G. WESSEL. *Nachr. Wiss. Göttingen, Math-phys. Kl. IIa, No.* 3, 5 *pp.* (1951) *In German.*

The asymmetry caused by isotope displacement in the shape of the absorption line $^1S_0$–$^1P_1$ of Ba I, previously detected by the authors with the atomic beam method, has been confirmed with interferometric measurements. The discrepancy with Arroe's results [Abstr. 183 (1951)] is discussed. L. PINCHERLE

535.338.333 : 539.155.2

5659. The isotope displacement between RaD and the stable Pb isotopes. P. BRIX, H. VON BUTTLAR, F. G. HOUTERMANS AND H. KOPFERMANN. *Nachr. Wiss. Göttingen, Math-phys. Kl. IIa, No.* 7, 2 *pp.* (1951) *In German.*

Interferometric measurements gave $(Pb_{208} - Pb_{210})/(Pb_{206} - Pb_{208}) = 1{\cdot}5 \pm 0{\cdot}1$, showing that a discontinuity in the isotope displacement occurs at the "magic number" $N = 126$, as it occurs at $N = 82$ and $N = 50$. L. PINCHERLE

535.338.4

5660. A new band system excited in acetylene. P. J. DYNE. Note in *Canad J. Phys.*, **30**, 79–80 (*Jan.*, 1952).

535.338.4–31

5661. The ultra-violet spectrum of a diatomic hydride. A. D. CAUNT AND R. F. BARROW. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 373–4 (*May*, 1952).

The results of a preliminary rotational analysis of five bands in the region 2150–2650 Å forming a $v' =$ constant progression are given. The emitter appears to be the hydride of a first-row element, perhaps CH^+ or OH^+. R. F. BARROW

535.34.08 : 535.343.3–15

5662. On a technique of studying absorption in the near infra-red; absorption spectra of some solvents of plastic materials. M. AUMERAS, B. LAUGROST AND R. MINANGOY. *Bull. Soc. Chim. France*, **19**, 311–15 (*March–April*, 1952) *In French.*

An optic image projected on a photo-cathode can be transformed into an electronic image, visible on a fluorescent screen. Such apparatus is described: used in conjunction with a spectrometer with flint-glass prism and a compensated electric thermo-couple. A dispersion curve was obtained from a mercury emission spectrum and a benzene absorption spectrum. Absorption spectra of several solvents were taken and interpreted. Solvation phenomena shown by polyvinyl chloride in cyclohexanone are discussed. A. J. TAYLOR

535.343

5663. Long wavelength absorption band of thiophene. M. R. PADHYE AND S. R. DESAI. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 298–9 (*April*, 1952).

An absorption band with two maxima at 3180 Å and 3130 Å $\varepsilon_{max} = 0{\cdot}048$ is found, possibly due to a singlet-triplet transition. C. TURNER

535.343–14

5664. Microwave spectrum of BrCN at six millimeters. S. J. TETENBAUM. *Phys. Rev.*, **86**, 440–6 (*May* 15, 1952).

69 lines of the $J = 5 \rightarrow 6$ pure rotational spectrum have been measured. Lines were found due to the following molecules in their normal isotopic abundances: $Br^{79}C^{12}N^{14}$, $Br^{81}C^{12}N^{14}$, $Br^{79}C^{13}N^{14}$, $Br^{81}C^{13}N^{14}$, $Br^{79}C^{12}N^{15}$ and $Br^{81}C^{12}N^{15}$. Transitions have been found in the vibrational states (0 0 0), (0 1^1 0), (1 0 0), (0 2^0 0), (0 2^2 0) and (1 1^1 0). The apparatus is described and experimental results are compared with those of previous investigators. Fermi resonance effects have been observed and analysed. A dependence of the *l*-type doubling constant on the bromine quadrupole field has been found. Quadrupole coupling constants have been determined for the first excited vibrational states in $Br^{79}C^{12}N^{14}$ and $Br^{81}C^{12}N^{14}$. A.

535.343–15

5665. Contribution to the study of the intensity of absorption lines and bands in the infrared. J. VINCENT. *J. Phys. Radium*, **13**, 59–67 (*Feb.*, 1952).

Continuation of a review [see Abstr. 3067 (1950)]. Outlines, for diatomic molecules, the deduction of formulae giving intensities of rotation lines and fundamental and harmonic vibration-rotation bands. The methods of wave mechanics and the older quantum theory are compared. Comparison with experimental intensities is promised in a future article.

G. F. LOTHIAN

535.343–15

5666. The infrared spectrum of methyl cyanide. P. VENKATESWARLU. Letter in *J. Chem. Phys.*, **20**, 923 (*May*, 1952).

The eighth fundamental of this compound, which could not be found in previous work [Abstr. 4249 (1951)] has now been obtained in the vapour and liquid. A. J. TAYLOR

535.343.2/.3–31

5667. On the ultraviolet absorption spectra of anisole in the liquid and solid states. A. R. DEB. *Indian J. Phys.*, **25**, 233–6 (*May*, 1951).

535.343.2/.3–31

5668. On the absorption spectra of toluene in the liquid and solid states. H. N. SWAMY. *Indian J. Phys.*, **25**, 262–4 (*May*, 1951).

The absorption spectra of toluene in the ultraviolet region have been investigated in the liquid state at 30°C and in the solid state at −180°C. An examination of the photographs reveals that lowering of temperature, contrary to the results reported by some previous workers, causes the bands to become wider; so that only one band is observed in the solid state, the others merging into one another. It is pointed out that the intermolecular field in the solid state has great influence on the electronic energy levels of the molecule. A.

535.343.2/.3–31

5669. On the ultraviolet absorption spectra of methyl benzoate and acetophenone in the solid state at low temperatures. A. R. DEB. *Indian J. Phys.*, **25**, 433–6 (*Sept.*, 1951).

In the case of methyl benzoate three broad bands have been observed in the liquid state in the region 2650 to 2900 Å. Continuous absorption begins below 2500 Å. In the solid state these bands are found to be shifted considerably towards the longer wavelength side, while continuous absorption begins below 2440 Å. The absorption spectrum of acetophenone in the liquid state reveals three broad bands with centres at 35 744, 38 748 and 40 277 cm^{-1} respectively. On solidification, the first band widens considerably on both sides and splits up into three bands, while the second shifts towards the shorter wavelength side and the third disappears. The limit of continuous absorption recedes towards shorter wavelength side. It is pointed out that these changes cannot be due to mere lattice fields and may be due to association of the molecules in the solid state. A.

535.343.22

5670. α- and β-bands in potassium bromide crystals. C. DELBECQ, P. PRINGSHEIM AND P. YUSTER. Letter in *J. Chem. Phys.*, **20**, 746–7 (*April*, 1952).

The β-band at 192 mμ appears when F-centres are formed in crystals. The α-band at 203 mμ is obtained by photochemical coloration at low temperature. C. TURNER

535.343.2–15

5671. Infrared reflection spectra of phosphates and arsenates. J. J. OBERLY AND G. WEINER. Letter in *J. Chem. Phys.*, **20**, 740–1 (*April*, 1952).

Spectra are taken of crystals of KH_2PO_4 and KH_2AsO_4 and similar ammonium compounds. An analysis is given: some structures are suggested, but an unambiguous assignment is not yet found. A. J. TAYLOR

535.343.32–15

5672. Near infrared absorption spectra of phenol solutions in some neutral solvents. V. M. ZEZYULINSKII. *Dokl. Akad. Nauk SSSR*, **81**, 633–5 (*No.* 4, 1951) *In Russian.*

535.343.4–15

5673. Absorption spectra of gaseous methyl halides at 1·6 μ. M. L. GRENIER-BESSON AND R. MATHIS-NOËL. *J. Phys. Radium*, **13**, 172 (*March*, 1952) *In French.*

By the use of new apparatus results described by Mathis-Noël [Abstr. 7709 (1951)] are confirmed. For the bromide and the chloride an extra band is found. A. J. TAYLOR

535.345 : 535.371 : 541.64

5674. On the proof of defined reversible associates ("reversible polymerizates") of acridinorange by absorption and fluorescence measurements in aqueous solution. V. ZANKER. *Z. phys. Chem.*, **199**, 225–58 (*Feb.*, 1952) *In German.*

The compound exists in 4 forms, differing in colour and in colour of their fluorescence. The form existing in the neutral region is strongly dependent on concentration in its optical behaviour. Red—and green—fluorescence were examined, showing that the cation forms reversible associates partly agreeing with

Scheibe's polymers. Dimerization-energy, dissociation constants and entropy, important for dimer-formation, were determined from the concentration- and temperature-dependence of the equilibrium position. J. JACOBS

535.345.6 : 535.242.63

5675. Contribution to the knowledge of filter errors in densitometric measurements. E. ASMUS. *Optik*, **9**, 108–25 (*No.* 3, 1952) *In German.*

The value of extinction coefficient (m) measured with a waveband of finite width varies with the thickness of specimen. Expressions are deduced for this variation in terms of the variation with wavelength of the intensity of the light source, transmission of the filter and the sensitivity of the detector. Results are computed, and confirmed by experiment, for typical solutions using a visual photometer with a filament lamp and commercial filters. It is shown that with an absorption cell of variable thickness measurements of m suitable for estimation of concentration may be made. G. F. LOTHIAN

535.347

5676. Modulation method of measuring dichroism. B. V. DERYAGIN AND V. V. KARASEV. *Zh. Tekh. Fiz.*, **21**, 708–9 (*No.* 6, 1951) *In Russian.*

535.371

5677. On the luminescence of alkali sulphides and sulphates. H. GOBRECHT AND D. HAHN. *Z. Phys.*, **132**, 111–28 (*No.* 1, 1952) *In German.*

By reduction of alkali sulphates phosphors are produced which show a red luminescence emission when excited by 3660 Å radiation and a blue luminescence when excited by 2540 Å radiation. The red luminescence shows a monomolecular decay and is due to polysulphide complexes while the blue luminescence is due to excess alkali metal atoms in the sulphate. G. F. J. GARLICK

535.371

5678. The luminescence of solutions of colouring substances. E. LAFFITTE. *J. Phys. Radium*, **13**, 148–60 (*March*, 1952) *In French.*

535.371

5679. Silver-activated alkali halides. H. W. ETZEL, J. H. SCHULMAN, R. J. GINTHER AND E. W. CLAFFY. Letter in *Phys. Rev.*, **85**, 1063–4 (*March* 15, 1952).

Absorption bands due to Ag^+ ions in NaCl crystals occur at 2095, 2170 and 2295 Å. Absorption of radiation of wavelength less than 2100 Å produces a u.v. fluorescence band at 2500 Å while irradiation at 2270 Å produces a band at 4000 Å. The 2295 Å absorption is ascribed to pairs of Ag^+ ions and that at 2170 Å to single Ag^+ ions (see also abstract following). G. F. J. GARLICK

535.371

5680. Color center formation in NaCl containing Ag^+. E. BURSTEIN, J. J. OBERLY, B. W. HENVIS AND M. WHITE. Letter in *Phys. Rev.*, **86**, 255 (*April* 15, 1952).

Measurement of absorption bands in NaCl–Ag crystals before and after irradiation by X-rays indicate that at low temperatures excited electrons are trapped at Ag^+ ions to make atomic Ag centres, but at room temperature the electrons are captured by complex Ag^+ ion centres (see preceding abstract). G. F. J. GARLICK

535.371

5681. Further evidence for the Lord–Rees–Wise theory of luminescence decay of ZnS–Ag. M. P. LORD. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 291–2 (*April*, 1952).

535.371

5682. Sensitive method of detection and microdosage of copper in solids, at different stages of preparation of luminescent substances. E. GRILLOT. *C.R. Acad. Sci.* [*Paris*] **234**, 1775–7 (*April* 28, 1952) *In French.*

After long irradiation in the Châtillon pile all solids contain radioactive Cu^{64}, the amount being proportional to the original content of Cu^{63}. The technique provides a means of determining the amount of Cu^{64} in zinc sulphide phosphors either during or after normal preparation. G. F. J. GARLICK

535.371 : 535.33.07

5683. Realization of a luminescent source as secondary standard for energy distribution. D. CHALONGE, P. GUÉRIN AND M. SERVIGNE. *C.R. Acad. Sci.* [*Paris*] **234**, 1443–5 (*March* 31, 1952) *In French.*

A mechanical mixture of several phosphors with emission regions from the orange-red to the ultraviolet (3200 Å) gives an excitation by a low-pressure mercury discharge lamp in a specially designed system, a continuous and reasonably constant emission spectrum over the above range. By separating the phosphor layer from the lamp, and by inserting between the two a 2537 Å transmitting filter the phosphor stability is maintained and the visible mercury lines eliminated. G. F. J. GARLICK

535.375.5 : 548.7

5684. Anomalies in the scattering spectrum of piezoelectric crystals. I. Evidence of elastic longitudinal and transversal waves in cubic crystals. L. COUTURE-MATHIEU, H. POULET AND J.-P. MATHIEU. *C.R. Acad. Sci.* [*Paris*] **234**, 1761–3 (*April* 28, 1952) *In French.*

The abnormal polarization of certain rays in the Raman spectra of Na chlorate and bromate follows from separation of transverse and longitudinal waves in the crystals. G. I. W. LLEWELYN

535.375.54

5685. Raman spectrum of *para*-dichlorobenzene. S. C. SIRKAR. Letter in *J. Chem. Phys.*, **20**, 742–3 (*April*, 1952).

The conclusion reached by Saksena [Abstr. 2563 (1951)] that the recorded Raman spectrum of *para*-dichlorobenzene is explained by free rotation of the molecule about an axis perpendicular to its plane at temperatures above 32°c is claimed to be inaccurate. G. I. W. LLEWELYN

535.375.54

5686. On the origin of low frequency Raman lines of *para*-dichlorobenzene and reply to S. C. Sirkar. B. D. SAKSENA. Letter in *J. Chem. Phys.*, **20**, 760–1 (*April*, 1952). See preceding abstract.

535.376

5687. On the fluorescence excited by alpha particles in solutions. M. AGENO AND R. QUERZOLI. *R.C. Ist. Super Sanità*, **15**, 28–31 (*No.* 1, 1952) *In Italian.*

A 10 millicurie source of Po was immersed in a 5% solution of terphenyl in xylene. Light was emitted

up to several mm from the source, though not by scattering of light or diffusion of Po in the liquid.

S. T. HENDERSON

535.376

5688. On the fluorescence excited by alpha particles in solutions. M. AGENO AND R. QUERZOLI. *R.C. Ist. Super. Sanità*, **15**, 32–5 (*No.* 1, 1952) *In Italian.*

Further experiments have shown that the effects reported (preceding abstract) are due to the conversion of α-particle energy into ultraviolet of >3000 Å wavelength, which subsequently excites visible fluorescence.

S. T. HENDERSON

535.376

5689. Luminescence of KCl–Ni and KCl–Cu phosphors excited by X-rays. I. A. PARFIANOVICH. *Zh. Eksper. Teor. Fiz.*, **21**, 1389–95 (*No.* 12, 1951) *In Russian.*

Results of experimental investigations on luminescence of KCl–Ni and KCl–Cu phosphors excited by X-rays are presented. The systems of levels of localization of the electrons storing the luminescent energy of these phosphors was established. The depth of incidence of the local levels of fixation and the properties of the latter were determined. The occurrence of flashes was observed in both phosphors and the levels of flash-luminescence identified with the *F*-levels. The temperature of quenching of the luminescence in the KCl–Cu phosphor was found and its quenching mechanism is discussed in the paper. The relation between the thermal and optical dissociation energies of the *F*-centre of the KCl–Ni phosphor was determined. Finally, the luminescence mechanisms and characteristics of the two phosphors are compared with those of NaCl–Ni and NaCl–Cu phosphors.

B. F. KRAUS

535.376

5690. Response of organic scintillators to *d–d* neutrons. R. A. ALLEN, L. E. BEGHIAN AND J. M. CALVERT. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 295–6 (*April*, 1952).

Pulse height distributions for scintillations from recoil protons in anthracene, trans-stilbene and diphenyl-acetylene due to *d–d* reaction neutrons are measured. Experimental distributions are compared with that calculated from data due to Taylor *et al.* [Abstr. 1668 (1952)].

G. F. J. GARLICK

535.376

5691. Recent research on radio-luminescence. G. F. J. GARLICK. *Brit. J. Appl. Phys.*, **3**, 169–72 (*June*, 1952).

During the last few years the development of sensitive photoelectron multipliers and of single crystals has made possible a quantitative study of luminescence in solids excited by electrons or by heavy particles. Previous empirical relations found between luminescence, electron potential and beam current are shown to be due to the complex structure of the powder-form screens used. Much simpler behaviour is indicated when the luminescence emission due to excitation of single crystals by single particles is investigated. In many inorganic crystals the luminescence is found to be proportional to the energy absorbed. Deviations from this linearity, particularly in organic crystals, provide indications of the nature of energy transport mechanisms in crystals. Studies of phosphors deposited as optically clear films on glass provide similar evidence and enable range energy relations to be studied for the exciting electrons. [illegible] earches have provided ideas on [illegible] three radiative processes in particle-ex[illegible] processes are of practical i[illegible]nt for at least 80% of the ene[illegible] absorbed by phosphor screens.

A.

535.39

5692. Precise localization of a transmission maximum or minimum as a function of wavelength. Application to the preparation of thin films. P. GIACOMO AND P. JACQUINOT. *J. Phys. Radium*, **13**, 59A–64A (*Feb. Suppl.*, 1952) *In French.*

The method described can be used for exact thickness determination of $\lambda/4$ films during their preparation. White light passed through the object is spread into a spectrum; this spectrum is then imaged on a photocell after reflection from a mechanically vibrated mirror. This causes a small section of the spectrum to oscillate over the entrance slit of the photocell. The theory is developed. The method is applied to the measurement of multiple films for interferometry and has high sensitivity.

S. TOLANSKY

535.412

5693. A method for production of high-intensity, multi-fringe Rayleigh interference patterns. H. SVENSSON. *Acta Chem. Scand.*, **5**, 1301–10 (1951).

Modifications are introduced into the Rayleigh interferometer for the study of refractive index changes in liquids. The single slit source is replaced by a grid of selected space constant. This leads to increased intensity in the fringe pattern, a matter of importance when rapid diffusion processes are taking place in the liquid under study. By placing a vertical raster behind a horizontal slit a rectilinear array of point sources is obtained. The patterns are useful for the optical analysis of multi-component boundary systems.

S. TOLANSKY

535.412 : 532.72

5694. On the use of Rayleigh–Calvet–Philpot interference fringes for the measurement of diffusion coefficients according to the moment method. H. SVENSSON. *Acta Chem. Scand.*, **5**, 1410–12 (1951).

A discussion of the integral interference fringes, produced with the Rayleigh interferometer, formed by bringing to interference one light beam passing through the cell and another passing through a comparison cell with a constant refractive index. It is shown how the diffusion coefficient may be calculated from observations made on fringe distribution.

S. TOLANSKY

535.417

5695. Interferometric studies on coals. S. TOLANSKY. Letter in *Nature* [*Lond.*] **169**, 660–1 (*April* 19, 1952).

Interference methods are applied to the examination of polished coal samples. The fringes reveal the degree of homogeneity, local reflecting coefficient, regions of different hardness and cleavages.

S. TOLANSKY

535.417

5696. Production of a high resolving power by means of multilayer coatings. A. H. JARRETT. Letter in *Nature* [*Lond.*] **169,** 790–1 (*May* 10, 1952).

Reflection, transmission and absorption characteristics are reported for multilayer mirrors, respectively 5 and 9 layers, on a quartz Fabry–Perot interferometer. Data are given for the green line. For 9 layers $R = 97\%$, $A = 2\%$, $T = 1\%$, the corresponding figures for 7 layers being 94%, 1%, 5%. The keeping properties of coatings are given. The resolving power of 10^6 is obtainable with 7 layers for 0·75 cm Fabry–Perot interferometer. S. TOLANSKY

535.417

5697. Production of a high resolving power by means of multilayer coatings. H. VON KLÜBER. Letter in *Nature* [*Lond.*] **169,** 790–1 (*May* 10, 1952).

A multilayer Fabry–Perot interferometer tested with an Hg 198 isotope lamp is applied to the examination of the solar absorption spectrum. High resolution and very high contrast are obtained, when the interferometer is crossed with a plain grating. Interferograms are illustrated for the red and the green regions of the sun spectrum.

S. TOLANSKY

535.42

5698. Diffraction of light by a semi-transparent sheet. F. B. PIDDUCK. *Quart. J. Math. Oxford* (*Ser.* 2) **2,** 316–20 (1951).

The Kirchhoff theory of diffraction can be derived as an approximation from the electro-magnetic theory, postulating dipoles radiating into a space obeying Maxwell's equations. This method is applied to the case of a thin disk of homogeneous conducting dielectric whose linear dimensions are small although much larger than the wavelength, and to the case of a straight edge of a semi-transparent sheet. The conditions under which the approximations hold are discussed and the forms taken by Babinet's principle given. R. W. FISH

535.42

5699. The representation by development in series of an arbitrary distribution of amplitude over a circular pupil and the calculation of the associated diffraction figure. B. DOSSIER. Letter in *J. Phys. Radium,* **13,** 169–70 (*March,* 1952) *In French.*

The integral for the amplitude of the diffraction image formed by a pupil with variable transmission can be transformed. The final expression is more convenient in practice as it contains a product of the amplitude with a uniform pupil and a series depending upon the transmission factor of the pupil. R. W. FISH

535.42

5700. Focusing by diffraction. A. V. BAEZ. Letter in *Amer. J. Phys.,* **20,** 311–12 (*May,* 1952).

The use of zone plates, holograms, etc., as means of focusing radiation is briefly reviewed. A method of making a zone plate for use with X-rays is suggested. R. W. FISH

535.42 : 534.26

5701. Intensity expressions for the diffraction of light by an amplitude modulated ultrasonic beam. R. R. AGGARWAL. *Acustica,* **2,** 20–2 (*No.* 1, 1952).

The intensity expressions for the various diffraction lines present in the pattern for an amplitude-modulated ultrasonic beam have been obtained, for small angles of incidence. The modulated wave behaves as three component waves and the relative intensities of the various types of lines provide a measure of the modulation depth. A.

535.42 , 538.566

5702. A rigorous formulation of the classical diffraction problem. H. HÖNL. *Z. Phys.,* **131,** 290–304 (*No.* 3, 1952) *In German.*

A direct treatment of diffraction by a plane slit of arbitrary width is given for a scalar theory by a Fourier transformation method which leads to two simultaneous integral equations for the wave function. For this problem, Meixner's finiteness-condition [Abstr. 5976 (1950)] is found to be satisfied at once. Relation to the Kirchhoff diffraction theory is discussed. R. H. DALITZ

535.42 , 538.566

5703. The diffraction of electromagnetic waves by a slit. I. E. GROSCHWITZ AND H. HÖNL. *Z. Phys.,* **131,** 305–19 (*No.* 3, 1952) *In German.*

The general theory developed previously (preceding abstract) is here applied to a slit, the solution of the scalar wave equation being obtained for the case where the wave function is zero on the surface of the screen. P. M. DAVIDSON

535.421

5704. New methods of making gratings. T. MERTON. *J. Phys. Radium,* **13,** 49–53 (*Feb.,* 1952) *In French.*

Methods of copying gratings in hardened gelatine are described. These copies give very good definition and can be made into reflection gratings by metallizing the surface. The original grating need not be plane, but may be a screw thread formed in a polished cylinder. Screws turned on a lathe usually have large periodic errors. A double nut of cork, carrying a ruling diamond, allows a crude thread on one part of the cylinder to be used as the parent thread for ruling an accurate thread on another part of the same cylinder. R. W. FISH

535.422

5705. Diffraction of spherical scalar waves by an infinite half-plane. K. L. MCDONALD AND F. S. HARRIS, JR. *J. Opt. Soc. Amer.,* **42,** 321–30 (*May,* 1952).

A theoretical discussion of the problem of diffraction of spherical scalar waves incident upon a thin black infinite half-plane, which makes use of Maggi's transformation, has previously appeared in the literature. However, previous treatments have been limited solely to the diffracted component. From the results of previous investigators a simple expression for the total energy distribution, which is suitable for computational purposes, is derived. The results are shown to reduce to Kirchhoff's formulation of the same problem, for field points not far removed from the shadow-boundary-plane. A rapid approximation method, applicable to the cases of plane and cylindrical waves, is also given. Experimental results were obtained from a photometer employing a refrigerated multiplier phototube. It is shown that the theoretical and experimental intensity distributions agree only when the radius of the point source

aperture becomes indefinitely small. Tests with metallic and non-metallic screens indicate that the nature of the edge of the diffracting screen (for points far removed from the screen) is of minor importance. Possibly of somewhat greater significance, but yet minor, is the nature of the body of the diffracting screen, a metallic screen tending to displace the fringes toward the shadow-boundary-plane. A.

535.543 : 535.415

5706. On the colours of thin films and their relationship to the colours of thin doubly-refracting crystal plates. G. C. Mönch. *Optik*, **9**, 97–107 (*No.* 3, 1952) *In German.*

The production of colour phenomena by reflections in a thin film and by a thin crystal plate between crossed Nicols is discussed. In both cases the spectral distribution of the intensity seen by the eye is calculated. The two phenomena are compared when the film and crystal thicknesses are such that the same wavelengths are extinguished and the initial light is adjusted so that in both cases the brightest part of the spectrum appears to have the same light strength. It is concluded that for equal path differences fundamental colour differences must occur. However, for the cases usually met with, these differences in tint are not important so that the same colours appear for equal phase differences. H. G. JERRARD

535.55

5707. Errors in stress determination at the free boundaries of "frozen stress" photoelastic models. V. M. Hickson. *Brit. J. Appl. Phys.*, **17**, 176–82 (*June*, 1952).

An attempt has been made to list the errors, apart from those due to the use of imperfect material, which may occur in the determination of free boundary stresses from direct relative retardation observations on slices cut from "frozen stress" photoelastic models and, where possible, to estimate their magnitudes. Particular regard is paid to the important case of a stress concentration, where small radii will introduce errors which would be negligible at other points on the boundary. A.

535.56

5708. Optically active molecules in an external field. M. B. Volkenshtein and E. K. Byutner. *Zh. Eksper. Teor. Fiz.*, **21**, 1132–8 (*No.* 10, 1951) *In Russian.*

It has been shown by Volkenshtein [Abstr. 7178 (1950)] that in the analysis of the properties of optically active anisotropic media, it is necessary to take into account not only dipole electric, and dipole magnetic, polarization, but also electric quadripole polarization. Otherwise the results would not satisfy the law of conservation of energy. In the present article the authors consider on this basis the behaviour of optically active molecules, in a gas or in a solution, under the influence of an external electric or magnetic field. In this analysis the Max Born method is used, in which the polarization of a molecule in a static field is expressed by means of 3-dimensional tensor of second rank. The analysis shows that in such a medium the light propagating at right angles to the external electric field, must be elliptically polarized. N. S. JAPOLSKY

535.581

5709. The simultaneous measurement of the magnitude and dispersion with wavelength of a small birefringence. J. E. H. Braybon and H. G. Jerrard. *J. Sci. Instrum.*, **29**, 194–6 (*June*, 1952).

A method of measurement is described in which a Babinet compensator and a spectrometer are used. The compensator is not orientated at 45° to the vibration direction of the polarizer, as is usual, but at a smaller angle. The contrast of the fringe system is maintained by correct setting of the analyser. The theory of the method is given and mention is made of the accuracy. This is greatest for phase differences less than 45°. Calibration curves are drawn and photographs given to illustrate the method as applied to the measurement of the phase difference introduced by a mica sheet. A.

535.61

5710. Spatial distribution of the radiation from the u.v. standard. F. Rössler. *Ann. Phys.* [*Lpz.*] **10**, 177–95 (*No.* 3, 1952) *In German.*

A study of the light distribution from the Hg vapour u.v. standard of Krefft, Rössler and Rüttenauer. The polar curve is given for a number of wavelengths from 3200 to 6300 Å and the relation of the spherical reduction factor to the lower energy level of the radiation is studied. Values are given for the luminance (brightness) distribution across the lamp. Finally the author discusses the values obtained by different workers for the relative intensities of the different lines in the u.v. J. W. T. WALSH

535.65

5711. Prediction of the color of dye mixtures on textiles. H. R. Davidson. *J. Opt. Soc. Amer.*, **42**, 331–2 (*May*, 1952).

The relationship between the ratio K/S and reflectance as derived by Kubelka and Munk has frequently been used for analytical work, but little attempt has been made to evaluate the accuracy of its application in colorimetric terms. This evaluation has now been made for dyeings by comparing the predicted colour with that actually obtained in textile dyeings, and the difference has been expressed in terms of Munsell notation. In this manner the accuracy of the method has been examined for acid, chromed and metallized dyestuffs on wool, for "acetate" dyes, and for direct and vat dyes on cotton. We find the accuracy of colour prediction for acid dyestuffs on wool to average $\pm 0{\cdot}5$ hue step $\pm 0{\cdot}1$ value step, and $\pm 0{\cdot}4$ chroma step. Predictions for the other applications are nearly as accurate except in those cases where interaction of dyestuff molecules occurs. A.

535.7 : 612.84

Physiological optics. *See Abstr.* 6232

535.81

5712. Properties of amorphous selenium and its use as an optical material. H. A. Gebbie and C. G. Cannon. Letter in *J. Opt. Soc. Amer.*, **42**, 277 (*April*, 1952).

Previous measurements of the constants of Se suggest that it should be transparent in the far i.r. and should have low dispersion in this region.

Measurements over the range 1–25 μ confirm this. The use of Se for lenses, prisms, windows, etc., for the i.r. region is suggested. R. W. FISH

535.81 : 535.345.1

5713. The measurement of the absolute transparency of dioptric objectives. J. EULER. *Optik*, **9**, 80–8 (*No.* 4, 1952) *In German.*

An arrangement of a uniform light source, diaphragms and photocell is described by which the transmission factor of a lens, and its variation with field angle and wavelength of the light can be determined. Results for typical photographic lenses are given. 11 references. R. W. FISH

535.822 : 535.42

5714. Experiments in diffraction microscopy. G. L. ROGERS. *Proc. Roy. Soc. Edinb. A*, **63**, 193–221 (*Pt III*, 1952).

Experiments have been performed, using purely optical methods, to verify and extend the theory of Gabor's diffraction microscope [Abstr. 4712 (1949)]. An elementary theory of the process is first given, from which certain generalizations are provisionally drawn. In particular, a focal length is attributed to any Fresnel diffraction pattern and the hologram derived from it by photography. The variation of this focal length with wavelength and scale factor is postulated by analogy with a zone-plate, and the power-rate for a hologram is defined. These deductions are then verified by experiment. Various other confirmatory experiments are then described. Adequate information is given about apparatus and technique to enable new entrants into this field to obtain satisfactory results with the minimum of preliminary trial. A.

535.822.9 : 535.33.07–15

5715. A reflecting microscope for infrared spectrometry. A. R. H. COLE AND R. N. JONES. *J. Opt. Soc. Amer.*, **42**, 348–52 (*May*, 1952).

A reflecting microscope designed for use in front of the entrance slit of a Perkin–Elmer single-beam infrared spectrometer is described. It is shown that the heating effect of the condensed beam on the sample is not significant except in the case of compounds which absorb strongly in the 3-micron region of the spectrum, and then only if the sample is unsupported. The instrument is being applied to the study of small quantities of material in solution and to single crystals. Spectra adequate for identification purposes may be obtained from less than 10 micrograms of a sample in solution. The minimum sample size is limited at present by the technique of sample transfer and if this can be improved, spectra could be obtained with about 1 microgram. Preliminary results using polarized radiation in the study of fatty acid crystals are also presented. A.

535.824

5716. Experimental study of the variation of the limit of resolution as a function of the coherence of the light. A. ARNULF, O. DUPUY AND F. FLAMANT. *C.R. Acad. Sci.* [*Paris*] **234**, 1544–6 (*April* 7, 1952) *In French.*

The resolution of a microscope has been shown in theory to depend upon the degree of coherence of the light. The resolution has been measured experimentally for a number of eye pupil diameters over a range of coherences for both centred and non-centred light. For small pupil diameters (0·16 mm) with centred light, the resolution follows the theoretical values. For larger pupils, the resolution is sensibly independent of the coherence. R. W. FISH

535.832

5717. The theory of spectacles for near vision. T. GRAFF. *Optik*, **9**, 126–38 (*No.* 3, 1952) *In German.*

The simple theory of spectacles for distant vision is shown to present difficulties when applied to powerful lenses used at near distances. Alternative theory for the design of these spectacle lenses is given. R. W. FISH

HEAT 536

536.2 : 536.46

5718. Contribution to the graphical study of thermally variable systems. J. JACQ. *C.R. Acad. Sci.* [*Paris*] **234**, 1537–9 (*April* 7, 1952) *In French.*

A new graphical method previously described [Abstr. 5345, 7799 (1951)] enables the variations of temperature in an enclosure limited by boundaries of the same type, or of two different types, and subject to a given source of heat, to be predicted. This note shows that the method is easily extended to the case of an enclosure limited by any number of boundaries. F. E. HOARE

536.2 : 538.3

5719. The solution of temperature distribution problems by computation and electrical analogy. J. C. WILLIAMS. *Brit. J. Appl. Phys.*, **3**, 197–9 (*June*, 1952).

The computational method of Dusinberre (1949) and the use of an electrical analogy for the solution of problems involving temperature distribution in solid bodies with various boundary problems are discussed briefly. The two methods are used to solve a simple problem, and the results compared with an analytical solution. The computation solution can be made as accurate as required by lengthening the calculation, an accuracy of 1% being easily obtained. The electrical solution, using simple and inexpensive apparatus, agrees with the analytical solution within 2%; this accuracy is obtained when the temperatures at the boundaries of the solid are either uniform or sinusoidal, an error of 4% being found for other boundary conditions. Change of thermal properties with temperature is neglected. The application of both methods to the solution of industrial problems involving conduction in 1, 2 or 3 dimensions, with heat losses from surfaces, is discussed. A.

536.21

5720. Thermal conductivity of carbons and graphite. S. MROZOWSKI. Letter in *Phys. Rev.*, **86**, 251 (*April* 15, 1952).

The variation with temperature is discussed in relation to the crystallinity. It is concluded that for baked carbons there is a source of resistance to heat

flow in addition to the pure boundary scattering, and that no reliable estimate of the crystallite sizes can be made by the application of the Debye formula.

E. H. DOCK

536.21

5721. The steady flow of heat through hot glass. B. S. KELLETT. *J. Opt. Soc. Amer.*, **42**, 339–43 (*May*, 1952).

A problem on the steady flow of heat through glass is treated mathematically. It is shown that though infrared energy is absorbed within a short distance by almost any glass, the re-radiation of energy by the glass itself is sufficient at glass-melting temperatures to cause a considerable flow of heat. At 1200°C the radiant heat flow within a common window glass is of the order of 50× the ordinary conductive flow. The effect is much less important at lower temperatures because the total radiant energy is smaller and because most glasses are very opaque to the longer infrared wavelengths involved. A.

536.21 : 536.48

5722. Heat conduction in alloys at low temperatures. I. ESTERMANN AND J. E. ZIMMERMAN. *J. Appl. Phys.*, **23**, 578–85 (*May*, 1952).

With a view to studying the mechanism of heat conduction in low conductivity alloys, a method has been devised by which the thermal conductivity of relatively small samples ($\frac{1}{8}$ to $\frac{1}{4}$ in dia., 1 to 2 in long) of various materials can be measured in the temperature regions obtainable with liquid N, liquid H and liquid He. Preliminary measurements on several commercial alloys (monel, inconel and stainless steel) gave Wiedemann–Franz ratios several times greater than the theoretical value of $2{\cdot}45\times10^{-8}$ watt-ohm/deg^2, the deviation being greater for annealed than for cold-worked specimens. This has been interpreted in terms of appreciable lattice conduction of heat in these alloys. Following these results, samples of an alloy of 90% Cu, 10% Ni were prepared with varying amounts of cold-work and with different grain sizes. Results with these samples were similar to those obtained with monel and inconel and confirm the hypothesis of lattice conduction. They also give a qualitative indication of the effectiveness of cold-work in limiting the lattice conduction of heat. A.

536.22/.23

5723. Coefficients of thermal conductivity in a granular stratum. M. E. AEROV AND N. N. UMNIK. *Zh. Tekh. Fiz.*, **21**, 1351–63 (*No.* 11, 1951) *In Russian.*

A method of determining the coefficient of thermal conductivity in a granular layer in which a gas or liquid flow exists is presented. The method works with temperature measurements on the axis of symmetry of the steady 2-dimensional heat flow. These measurements show the equality of the coefficients of conductivity along and across the gas flow. The coefficients of conductivity, neglecting radiation, for glass balls, gravel and catalytic substances in the form of spherules, tablets and Raschig rings were measured in the interval of Reynolds numbers $Re = 0{\cdot}01$–3000 in flows of dry air, H_2 and CO_2. For badly conducting porous grains of spherical shape or tablets of insignificant roughness an empirical relation, valid for the range $Re = 10$–3500, was found: $\lambda/\lambda_{gas} = 10{\cdot}5 + BRePr$, where $Pr = c_p\mu/\lambda_{gas}$ is the Prandtl criterion for the gas penetrating the granular stratum. B. F. KRAUS

536.23 : 533.73

5724. Measurement of the thermal accommodation coefficients of gases. A. E. J. EGGLETON, F. C. TOMPKINS AND D. W. B. WANFORD. *Proc. Roy. Soc. A*, **213**, 266–73 (*June* 24, 1952).

Widely different values of the accommodation coefficients of inert gases at metal surfaces have been reported in the recent literature, but reasonably concordant results have generally been obtained by different workers when the flashing procedure of Roberts was used. This technique was therefore critically examined by Bremner [Abstr. 4905–6 (1950)], who concluded that the low values of Roberts were in error because the original thermal steady state was not attained. If this criticism is valid, then a reassessment of Roberts's conclusions in the application of them to the chemisorption of gases on metals is necessary. The techniques employed by Roberts and Bremner have therefore been investigated, and have shown that the conclusions given by Roberts are substantially correct. A.

536.23 : 536.25

5725. Phenomena of free convection in a granular stratum. M. E. AEROV AND N. N. UMNIK. *Zh. Tekh. Fiz.*, **21**, 1345–50 (*No.* 11, 1951) *In Russian.*

Free convection currents are set up by temperature rises in granular strata filled with a gas of comparatively high specific gravity, and these lead to a considerable increase of the effective thermal conductivity of the granular layers. This phenomenon, discovered in 1936, is of a considerable importance for high-pressure processes, combustion in metallurgical furnaces, gas generators with coking shafts, and catalytic processes, where it is very important for the first sections of the catalytic convertors with a high temperature gradient and concentration. However, this problem has not so far been treated quantitatively. The author's tentative relation between convection current and effective thermal conductivity of the granular stratum (under the simplifying assumption of the absence of a temperature gradient between gas flow and solid particles) based on considerations of similitude, is successful in establishing the conditions of the occurrence of a convection current, and in the determination of its intensity as well as of the increase in the thermal conductivity owing to the convection current. The results are fully borne out by the experiments. B. F. KRAUS

536.24

5726. Heat conduction and diffusion in a liquid medium in a periodically varying flow. I. Evaluation of the coefficient of wave transfer in a tube, in a slot, and in a channel. P. L. KAPITSA. *Zh. Eksper. Teor. Fiz.*, **21**, 964–78 (*No.* 9, 1951) *In Russian.*

It has been previously shown by the author that the so-called "diffusion transfer" of heat can be very much increased by a periodic motion of the liquid [Abstr. 3132 (1948)]. The present paper is devoted to the quantitative analysis of this phenomenon. The increase of heat transfer is expressed by means of a

-dimensional tensor of second rank, which is called ne "coefficient of wave transfer." The derivation egins from first principles. An approximate method shown, allowing the coefficient of wave transfer to be alculated when the distribution of velocities is known. his method is applied to the plane problem and to he tube of circular cross-section. A rigorous theory f the phenomenon is also applied to the latter case. n this application the differential equations are tated with reference to cylindrical co-ordinates and he solutions are expressed in terms of Bessel functions f the first kind of radial co-ordinate, which have a omplex argument and can, therefore, be resolved in erms of "ber" and "bei." The approximate method s also applied to the flow in an open channel. The umerical examples, worked out to illustrate the heory, show that the wave-like motion can increase he actual transfer of heat many times.

N. S. JAPOLSKY

536.24

5727. Heat exchange from pipes filled with a granular material. M. E. AEROV AND N. N. UMNIK. *Zh. Tekh. Fiz.*, **21**, 1364–71 (*No.* 11, 1951) *In Russian.*

The heat exchange process from a pipe with a granular stratum through which a gas flows is considered. The conception of a skin resistance to heat transfer at the pipe wall is introduced. A relation between the general heat exchange coefficient from the tube with a granular layer with the coefficient of thermal conductivity of the layer and the heat exchange coefficient at the tube wall was found. The relation determining, for grains of non-conducting material, the value of the exchange coefficient at the tube wall in the interval of Reynolds numbers 150–4000 takes the form $Nu_{wall}/Pr^{1/3} = 0{\cdot}155\ Re^{3/4}$, where Nu_{wall} is the Nusselt coefficient at the wall, Pr the Prandtl criterion.

B. F. KRAUS

536.24

5728. Temperature oscillations on the surface of an infinite wall under intermittent heat exchange. A. M. SHKLOVER. *Zh. Tekh. Fiz.*, **21**, 1372–8 (*No.* 11, 1951) *In Russian.*

Temperature oscillations along an infinite wall under harmonic heat exchange conditions have been treated in the literature several times. Yet for practical purposes, much the more important case is that of intermittent heat exchange, i.e. a heat exchange at a constant level periodically alternating with intervals during which the exchange is zero. The latter is considered in the paper. The method is based on Euler's summation method applied to the Fourier expansion of the problem and yields formulae and tabulated values for ready application to practical problems.

B. F. KRAUS

536.24

5729. The heat loss from wires in still air. Contribution on the estimation of numerical values. J. FISCHER. *Z. angew. Phys.*, **4**, 90–4 (*No.* 3, 1952) *In German.*

Values for the heat transfer coefficient and the mean heat loss loading are determined in terms of non-dimensional quantities, and the results are compared with those of Nusselt, Rice and McAdams. Relations between these quantities, temperature excess and wire diameter are given graphically.

E. H. DOCK

536.41 : 536.63 : 536.71

5730. On the transition points of crystalline beryllium oxyacetate. J. JAFFRAY. *C.R. Acad. Sci.* [*Paris*] **234**, 1539–40 (*April* 7, 1952) *In French.*

Transitions in $Be_4O(CH_3COO)_6$ have been examined over a range from 10°C to 160°C using a more sensitive method. In addition to the transition at 40°C two others equally sharp have been found near 75°C and 125°C. These three transitions appear to be of the same type, namely specific heat anomalies without latent heat. Between 150°C and 160°C the existence of a polymorphic transformation is confirmed. A transition at 10°C much less noticeable than the others has also been found. The coefficient of expansion has been studied and the transitions at 40°C, 75°C and 125°C are shown by maximum values of the expansion coefficient, not by abrupt changes in volume; that at 150°C is shown by a sharp increase of volume with temperature. An anomaly in dilatation previously reported by others is considered to be non-existent. At the polymorphic transformation a small discontinuity occurs in the electrical conductivity (σ) and a clear change of slope in the curve of $\log \sigma$ *v.* $1/T$.

F. E. HOARE

536.422

5731. Direct determination of the sublimation energy of carbon. T. DOEHAERD, P. GOLDFINGER AND F. WAELBROECK. Letter in *J. Chem. Phys.*, **20**, 757 (*April*, 1952).

The value of 141·26 kcal has been obtained using a new apparatus in which the rates of evaporation from a hot C surface and of effusion from a graphite furnace were investigated over the range of 2450–2840°K.

F. LACHMAN

536.422

5732. Recent determinations of the vapor pressure of graphite. L. BREWER. Letter in *J. Chem. Phys.*, **20**, 758–9 (*April*, 1952).

Some inconsistencies in the communication reported in the preceding abstract (dependence of p upon the ratio of orifice to evaporating area, and the role C_2 is claimed to play in the evaporation process) are pointed out.

F. LACHMAN

536.422

5733. On the mechanism of evaporation of graphite. F. WAELBROECK. Letter in *J. Chem. Phys.*, **20**, 757–8 (*April*, 1952).

The disagreement between the experiment and the generally accepted theoretical curves of C pressure is eliminated if functions $p_{ev} = p_{1eq}f_1 + 2^{\frac{1}{2}}p_{2eq}$ and $p = p_{1eq}f_1/(f_1 + \sigma) + 2^{\frac{1}{2}}p_{2eq}$, calculated in mass units (not as a number of particles) are accepted for pressures determined by the Knudsen cell and crucible experiments, respectively, the subscripts 2 referring to evaporation of C_2.

F. LACHMAN

536.423.15

5734. The evaporation coefficient of potassium between 66 and 111°C. K. NEUMANN AND K. SCHMOLL. Note in *Naturwissenschaften*, **39**, 131–2 (*No.* 6, 1952) *In German.*

Comparison of the measured evaporation of a drop

with that given by the Knudsen formula, which connects rate, vapour pressure, molecular weight, and temperature, allowed the evaporation coefficient to be measured. It varies very little from unity over the temperature range investigated. L. G. CARPENTER

536.423.4 : 530.162

The condensation phenomenon of an ideal Einstein–Bose gas. *See Abstr.* 5562

536.46

5735. Soot formation and radical equilibrium in flames. H. BEHRENS. *Z. phys. Chem.*, **199**, 1–14 (*Jan.*, 1952) *In German.*

It is suggested that the reaction $H + CO = C(solid) + OH$ is an intermediate stage in the attainment of Boudouard equilibrium in soot-producing flames. If this is so, the luminosity due to the presence of soot-particles can be used as a convenient indicator of the relative concentrations of H and OH radicals in those flames in which equilibrium in this reaction is set up. The method is applied to feebly-luminous pre-mixed C_2H_2-air flames. The luminosity of these flames is most intense in a zone immediately following the combustion front; this is attributed to soot formation by the above mechanism, arising from a local enrichment in H radicals which are formed in the combustion zone, but which recombine much more slowly than OH radicals also formed at the flame front. A secondary luminosity, appearing as a mantle around the flame, may be due to diffusion of H radicals into the flame from the region of secondary combustion in the atmosphere. It is pointed out that the use of soot-luminosity as a radical-indicator is not directly applicable when equilibrium is not set up in the intermediate reaction (this is the case in pre-mixed benzene-air flames); nor is it applicable when soot is also formed by some other reaction, as e.g. by "cracking" of hydrocarbons in some diffusion flames [Abstr. 961 (1952)]. A. SCHOFIELD

536.46

5736. Pressure dependence of quenching distance of normal heptane, iso-octane, benzene, and ethyl ether flames. R. FRIEDMAN AND W. C. JOHNSTON. Letter in *J. Chem. Phys.*, **20**, 919–20 (*May*, 1952).

Experiments on pre-mixed flames in air at pressures (p) of 0·25 atm. and 1·00 atm. and ambient temp. 100°C showed that if the minimum quenching distance is proportional to p^{-n}, the value of n for all the above fuels lies between 0·87 and 0·92. This is in close agreement with earlier results on propane [Abstr. 7198 (1950)]. If the fuels are arranged (*a*) in order of quenching distances (for lean and stoichiometric mixtures) and (*b*) in order of burning velocities, the two arrangements (*a*) and (*b*) are in inverse sequence. This is to be expected on theoretical grounds.

A. SCHOFIELD

536.46 : 537.566

5737. On the ionization and luminescence of flames. E. SÄNGER, P. GOERCKE AND I. BREDT. *Z. phys. Chem.*, **199**, 46–68 (*Jan.*, 1952) *In German.*

A German translation of a paper published earlier in French [Abstr. 243 (1952)]. Figures 1 and 2, which were erroneously interchanged in the French version, are here correct. A. SCHOFIELD

536.46 : 541.127

5738. On the mechanism of pre-detonation acceleration of a flame. A. S. SOKOLIK; YA. B. ZELDOVICH. *Zh. Eksper. Teor. Fiz.*, **21**, 1164–71 (*No.* 10, 1951) *In Russian.*

It is suggested that a weak shock-wave is generated by ignition of the gas-mixture, and travels ahead of the flame; behind this shock-wave the unburnt gas moves in the same direction as the flame, so that although the flame-velocity remains the same relative to the gas in which it is moving, it accelerates relative to the tube-wall. The accelerating flame itself generates a continuous series of weak shock-waves into the unburnt gas, each travelling slightly faster than its predecessor. Consequently the flame accelerates continuously, until all the shocks coalesce into one shock-wave of large amplitude. At this point a detonation wave is set up. Since the flame-speed relative to the gas is small (5–10 m/s) compared with the forward velocity of the gas, it would be expected, on this theory, that the final pre-detonation flame-speed would approx. equal the gas-velocity behind the detonation shock-front. In a wide range of gas-mixtures this is shown to be so. An exception (C_2H_2–O_2 mixtures near the limit of detonation) is attributed to the fact that in this mixture, detonation "spin" takes place, when the onset of detonation is brought about by localized ignition ahead of the flame-front due to the reflection of shock-waves at irregularities in the inner surface of the containing tube. Commenting on the suggested mechanism, Zeldovich points out that no mechanism for the formation of the shock-waves is put forward, and draws attention to an alternative theory due to Shchelkin and himself, in which the flame-acceleration is attributed to pre-flame turbulence. He also believes that the correspondence between final flame-speed and the gas-velocity behind the detonation shock is fortuitous, and not a verification of the suggested mechanism, because Sokolik has, in calculating the gas-velocity, used the final pressure of the products of detonation, whereas it has been shown (by Zeldovich) that the shock pressure in the detonation front exceeds the final pressure by a factor of two. In reply, Sokolik mentions that Zeldovich himself has earlier demonstrated that the critical Reynolds number is not exceeded ahead of accelerating flames, as Shchelkin supposed, and that no distortion of the accelerating flame-front has been observed photographically. He also states that as the only basis for believing that the pressure in the detonation-shock-front is twice that in the reacted products is the theory due to Zeldovich, which has for a long time remained unsupported by direct experimental proof, he has felt himself free to ignore this in his calculations.

A. SCHOFIELD

536.48 : 532.7

5739. The radial distribution function in liquid helium. P. J. PRICE. *Phys. Rev.*, **86**, 495–6 (*May* 15, 1952).

It is pointed out that the Ornstein–Zernike–Gibbs formula, which is commonly used to connect the intensity of coherent scattering of radiation in a liquid with the thermodynamic functions, is not valid for liquid helium. Alternative formulae involving the radial distribution function are discussed. A.

536.48 : 538.2

40. An investigation of the magnetic properties of uid He^3. E. F. HAMMEL, H. L. LAQUER, S. G. DORIAK AND W. E. MCGEE. Letter in *Phys. Rev.*, , 432 (*May* 1, 1952).

Reports experimental examination of the magnetic operties of liquid He^3 using (*a*) a heterodyne beat ethod, and (*b*) a low-frequency method. No nuclear romagnetism was observed. R. B. DINGLE

536.48

41. On the velocity of transfer by the He II film. N. ESELSON AND B. G. LAZAREV. *Dokl. Akad. auk SSSR*, **81**, 537–9 (*No.* 4, 1951) *In Russian.*

The transfer rate was determined by observations the change in level of He in a glass ampoule placed a shielded glass vessel partially filled with He and nnected with the dewar by a valve. Chief results ere: when the ampoule was lowered right into the lium, filled to the brim, and raised again, the transfer te was found to be independent of the difference in vels between He in ampoule and glass vessel, cept when the He was close to the brim of the npoule. If the ampoule was partially filled by flow rough the film, and then lifted up, the transfer rate as appreciably less. R. B. DINGLE

536.48

42. Helium II transfer rates on lucite and Perspex rfaces. B. S. CHANDRASEKHAR. Letter in *Phys. ev.*, **86**, 414 (*May* 1, 1952).

Perspex polished with commercial liquid polish ows a high film transfer rate with a maximum near 5°K and dependence on liquid level, a behaviour milar to that observed by Dash and Borse [Abstr. 931 (1951)]. When polished with rouge the surfaces both lucite and Perspex appeared smoother under e microscope and gave lower transfer rates with utter maxima. The results are interpreted as a mbination of film flow and capillary flow in cracks. ne latter persists to a small extent even 0·7° above e λ-point [see also Abstr. 4316 (1952)]. H. LONDON

536.48

43. Superflow of helium II through narrow slits. . BOWERS AND K. MENDELSSOHN. *Proc. Roy. oc. A*, **213**, 158–75 (*June* 24, 1952).

The flow of liquid He II has been investigated under adients of pressure and temperature in slits of 1 μ a. Besides the flow rate, the heat current and the essure difference at the ends of the slit, the pressure an intermediate point within the slit has been termined. It was found that for superflow the ntire drop in pressure and temperature occurs at the rrowest place in the slit. In the remainder of e slit, mass flow takes place under effectively zero adient of pressure or temperature. The experiments so indicate the existence of a critical flow rate yond which frictional dissipation makes its appear- nce. The critical rate was determined by four fferent criteria which yielded consistent results. The mperature dependence of the critical rate is similar that observed in the He II film. With flow under a mperature gradient and for higher flow rates the ydrostatic pressure within the slit was found to drop low that at the ends and an explanation for this effect has been suggested. Some experiments with wider slits have shown that in these, even for small velocities, the transport is a mixture of superflow and normal flow, which renders the phenomena very complex. A.

536.48

5744. Derivation of the velocity of second sound from Maxwell's equation of transfer. R. B. DINGLE. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 374–6 (*May*, 1952).

Assuming that second sound can be described in terms of the distribution function for the excitations only, the formula $c_2^2 = TS^2/C\rho_n$ for the velocity of second sound is derived from Maxwell's equation of transfer. Landau's expression for ρ_n appears naturally during the course of the derivation. It is suggested that the discrepancy between this formula for c_2 and Landau's result $c_2^2 = TS^2\rho_s/C\rho\rho_n$ arises from the inadequacy of a description in terms only of the excitation distribution function. R. B. DINGLE

536.483

5745. On new methods of insulating very low temperature apparatus. A. B. FRADKOV. *Dokl. Akad. Nauk SSSR*, **81**, 549–51 (*No.* 4, 1951) *In Russian.*

Partially evacuated "mipora," an expanded urea formaldehyde plastic (density 18–22 kg/m³, porosity 97–98%) combines the cheapness and durability of solid insulation with the excellent properties of high vacuum as thermal insulation for low-temperature apparatus and containers for liquid O, H, N, CH_4, etc. Plotted test results show the rates of evaporation of liquid air and liquid H from a cylinder insulated by high vacuum (10^{-5} mm Hg), partial vacuum, "mipora" at atmospheric pressure, evacuated "mipora" (to 10^{-2} mm Hg for liquid air, and 0·2 mm Hg for liquid H) and "mipora" filled with H and then evacuated. Evacuation to 10^{-2} mm Hg lowers the thermal conductivity of "mipora" at liquid air temperatures from 0·022 to 0·0025 kcal/m hr °C.

A. GELBTUCH

536.521 : 535.338.35

5746. Temperature measurement by the line reversal method for short duration aperiodic processes. F. RÖSSLER. *Z. angew. Phys.*, **4**, 22–9 (*No.* 1, 1952) *In German.*

The method, by the addition of a modulating arrangement consisting of two polaroids, one rotating and the other fixed, between the source (a carbon arc) and the flame (a non-luminous Bunsen with NaCl), is extended to short duration processes. The spectrum is recorded photographically on a rotating drum and the position of reversal obtained from the trace. Speeds of rotation of the polaroid up to 3000 rev/min were used. The results are independent of the plane of polarization of the light. Decreasing concentration of the salt increases the region of reversal. The effects of dispersion, slit width and height, and resolving power, on the accuracy obtainable are considered. As a test of the apparatus the temperature of the radiation from a rocket jet of $\frac{1}{4}$ sec duration was measured. The photographic trace and results are given. S. WEINTROUB

536.531

5747. A simple resistance thermometer. H. S. EISNER. Letter in *J. Sci. Instrum.*, **29**, 166 (*May*, 1952).

Describes the construction of a small cylindrical collodion-bound Pt resistance thermometer of very low thermal capacity and resistance $\simeq 40\,\Omega$. It has been used, with a simple lead-compensated bridge circuit, for measurement of ambient air temps. between $-20°$ and 50°C, with an accuracy of $\pm 0{\cdot}05$°C.

W. C. MOSS

536.531 : 536.48

5748. The low temperature characteristics of carbon-composition thermometers. J. R. CLEMENT AND E. H. QUINNELL. *Rev. Sci. Instrum.*, **23**, 213–16 (*May*, 1952).

A semi-empirical equation relating resistance and temperature and having three adjustable constants is given. Temperatures calculated by this equation are within $\pm 0{\cdot}5\%$ of the measured temperatures from 2° to 20°K. Temperature values are reproducible within about $\pm 0{\cdot}1\%$ from run to run, making possible the interpolation of temperatures from 4° to 10°K on the basis of calibrations in liquid H and He only. Thermometric sensitivity is such that by measuring resistance to one part in 5000 it is possible to detect temperature changes smaller than 0·01° at 20° and smaller than 0·0001° at 2°K. The variation of resistance with measuring current can be interpreted as Joule heating of the resistor by the measuring current. Magnetic field sensitivity is small, the change in resistance with field being proportional to H^2. Equations are given which permit an estimate of the resistance-temperature curve of a resistor on the basis of its room temperature resistance. A.

536.532 : 578.087.86

5749. The measurement of respiratory air temperature. P. WEBB. *Rev. Sci. Instrum.*, **23**, 232–4 (*May*, 1952).

To reduce error in measuring rapidly fluctuating air temperatures within a body cavity, a small, shielded thermojunction was devised. Experimental evaluation demonstrated that it read changing air temperatures to $\pm 0{\cdot}1$°C with a 50% response time of 0·2 sec at air flows exceeding 2 litres/min. The technique of making the small junction and the recording apparatus is described. A.

536.631 : 537.312.62

Behavior of the heat capacity of superconducting niobium below 4·5°K. *See Abstr.* 5796

536.654 : 539.132

On an interpretation of the limits of pre-dissociation in the spectrum of carbon monoxide and the latent heat of sublimation of graphite. *See Abstr.* 5950

THERMODYNAMICS 536.7/.8

536.7

5750. On a theorem of irreversible thermodynamics. H. B. CALLEN AND R. F. GREENE. *Phys. Rev.*, **86**, 704–10 (*June* 1, 1952).

A relation is obtained between the parameter describing the irreversible response of a driven dissipative system and the spontaneous fluctuations of the thermodynamic extensive parameters of the system in equilibrium. The development given in this pape extends the theorem, previously proven in the statistica mechanical domain, to the macroscopic thermo dynamic domain. A

536.7 : 537.312.6

5751. On the thermodynamics of a Fermi gas wit exchange. W. ZIMMERMANN. *Z. Phys.*, **132**, 1–2 (*No.* 1, 1952) *In German.*

This is considered in connection with Fröhlich method for superconductors. The result found b Fröhlich for $T = 0$ is confirmed in essentials; it shown, however, that no explanation of the know anomalies in the specific heats of superconductors found in the Fröhlich theory in its present form.

F. E. HOAR

536.7

5752. Concerning the general thermodynamic theo of the equation of state. R. BERGEON. *C.R. Aca Sci.* [*Paris*] **234**, 1540–2 (*April* 7, 1952) *In French.*

Foulkes [Abstr. 1748 (1952)], from a gener theorem regarding the equation of state, has show that the second virial coefficient may be writte $bT^{-n} + b'(n, b, b'$ constants). Using Foulkes's resul the author deduces the value of n as $C_p(dT/dv)_p/p$ ar calculates its value for nitrogen, showing it to va widely particularly near the critical point. The reas for this is traced to the formulation of the origin conditions in the general theory. F. E. HOAR

536.7

5753. Thermodynamic properties of chlorine t fluoride. M. D. SCHEER. Letter in *J. Chem. Phys* **20**, 924 (*May*, 1952).

Contains a table of the free energies, entropies a heat capacities, using Smith's structure, and Schaf and Wickes's [*Z. Electrochem.*, **52**, 205–9 (1948 frequencies. C. TURN

536.7

5754. Plug transfer between two phases kept constant pressures. R. O. DAVIES. *Physica*, **18**, 270 (*April*, 1952).

The usual thermodynamic discussion of the Joul Kelvin effect is incomplete because it assumes t existence of a stationary state with fixed Δp. Such stationary state is not possible for an adiabatica isolated system with non-zero heat of transfer. Th a "pseudo stationary state" can be set up in which remains constant (for fixed Δp) while the temperatur of the cylinders vary in time. The relati $\Delta T/\Delta p = -M^*vT$ is then analogous to the therm mechanical formula $\Delta p/\Delta T = -Q^*/vT$. For Knu sen transfer through a small aperture, $M^* = -$ (*at.wt.*)/9*RT*.

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.1

5755. A precise determination of the charge of t electron from shot-noise. L. STIGMARK. *Ark. Fy* **5**, 399–426 (*Paper* 19, 1952).

An experimental determination of the charge

the electron was carried out from shot fluctuations of saturated currents from a special diode passing a tuned circuit resonating at 600 kc/s. Precision measurements of the circuit parameters and the mean square value of the shot noise from the circuit has given as a final result $e = (4{\cdot}797 \pm 0{\cdot}012)10^{-10}$ e.s.u. A.

ELECTROSTATICS . DIELECTRICS 537.2

537.213

5756. Contact potentials of reacting layers of zinc oxide prepared at various temperatures. R. Hirschberg and E. Lange. Note in *Naturwissenschaften*, **39**, 187 (*No.* 8, 1952) *In German.*

The potential varies from +340 mV for layers at 25°C to zero at 270°C and to −240 mV at 410°C. Activation energies for the various processes involved are estimated. Similar results are obtained with the systems Sn/SnO_2, Ag/Ag_2O and Cd/CdO.

C. A. HOGARTH

537.213

5757. On the application of surface potential analysis. S. Koga. *Japan Sci. Rev.*, **1**, 51–4 (*June*, 1950).

A vibrating plate condenser method is used to measure the surface potentials of metals under various conditions. Experimental details of the apparatus are given and several graphs show the effect of oxidation on the surface potential. The theory of surface potentials is discussed briefly. J. IBALL

537.221 : 539.16.08

5758. Study of the distribution of surface potential by means of radioactive deposits. T. Westermark and L.-G. Erwall. Letter in *Nature* [*Lond.*] **169**, 703–4 (*April* 26, 1952).

Contact potentials of polished metallic surfaces have been studied using a radiothorium source (0·2 mC). Differences of 0·1 V could be observed with one arrangement. Insulators show an effect which apparently is related to their surface resistivity. Application of the method to mineral sections, alloys and biological materials is mentioned. A. E. KAY

537.221 : 621.3.066.6 : 621.315.59

5759. Contribution to the theory of the silicon carbide contact. E. Holm. *J. Appl. Phys.*, **23**, 509–17 (*May*, 1952).

The high limiting contact voltage of 40 to 50 V in contacts between silicon carbide members (single crystals of the black-green variety) is explained on the basis of the known temperature-voltage relation. Practically clean silicon carbide possesses a superficial layer which functions as a potential hill for the electrons. Because of its thinness the hill is penetrable for the electric current by means of the tunnel effect. The tunnel resistance per unit area was investigated with terminal areas of the order of 2 mm². Being constant at small voltages, it drops down through some orders of magnitude within the voltage range of 0·5 to 5 V, showing that the work function for emission of electrons into the barrier material from the adjacent metal is of the order of 3 eV. From the amount of the tunnel resistance it is concluded that the thickness of the potential hill is of the order of 10 to 20 Å. The simultaneity of applied voltage and tunnel current is demonstrated. A.

537.226

5760. On mechanical action in dielectrics. R. Cade; W. B. Smith-White. Letters in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 287–9 (*April*, 1952).

See Abstr. 9439 (1951), 986 (1952). The controversy is reduced to the problem of setting up a force density function when the force acting on an element depends upon the shape of the element. R. A. NEWING

537.226.1.08 : 621.3.011.5 : 621.317.335.3

5761. The computation of dielectric constants. R. M. Redheffer, R. C. Wildman and V. O'Gorman. *J. Appl. Phys.*, **23**, 505–8 (*May*, 1952).

The short-circuited-line method is considered as applied to general samples, not restricted to quarter-wave, half-wave, thin or low-loss. The complex permittivity can be obtained by combination of two measurements, the sample being followed by short and open circuit, respectively. The equation is simple, non-transcendental and unambiguous. It lends itself to complete graphical representation. When only a single measurement is made, as in conventional practice, a change of variable leads to great simplification of detail. With due regard to the nature and magnitude of experimental errors, the conditions for optimum graphical representation are analysed, and a reasoned determination of scale-ranges given. Large-scale curves have been constructed, but only reductions are given here. A.

537.226.2

5762. The phase transition of barium titanate near 120°C. N. A. Roĭ. *Dokl. Akad. Nauk SSSR*, **81**, 545–7 (*No.* 4, 1951) *In Russian.*

The dielectric constant ε of a block of $BaTiO_3$ was measured at 130 kc/s at temperatures of 100° to 140°. The temperature was measured to 0·1° and was changed slowly from 100–140–100° over 7–8 hr. Marked thermal hysteresis was found, the loop width being 1·2°. Measurements were repeated with up to 30% of added $SrTiO_3$, which depressed the maximum ε by about 10% and lowered the temperature at which the maximum occurred to 32·5° (for 30% addition). The loop width remained much the same. The phase transition is thought to be of the first order and to be analogous to the transitions at 0° and −90°.

A. L. MACKAY

537.226.2

5763. Measurement of the dispersion and absorption behaviour of a non-associating polar liquid in the region of 1 to 80 cm wavelengths. W. Meckbach. *Z. Phys.*, **131**, 331–53 (*No.* 3, 1952) *In German.*

The refractive index n and absorption coeff. nx for α–Br–naphthalene were determined in closed waveguides; n for 1·3–80 cm from wavelengths of standing waves in air and dielectric, nx for 2·3–30 cm from exponential decay of progressing waves in liquid. The behaviour of the real and imaginary parts of the dielectric constant, deduced from experimental data, differ appreciably from Debye theoretical values.

Conclusions based on this theory about the dispersion region from longer wavelength measurements seem therefore not allowed. The dependence of effective relaxation time on wavelength has the expected behaviour for the theory of 3 relaxation times.

J. JACOBS

537.226.2

5764. On the absorption of u.h.f. radio waves in fatty acids. S. N. SEN. *Indian J. Phys.*, **25**, 237–45 (*May*, 1951).

The absorption of ultra-high frequency radio waves in lower fatty acids (formic acid, acetic acid, propionic acid and *n*-butyric acid) was studied in the frequency-range 250–510 Mc/s at different temperatures by the optical method. An absorption maxima was observed in the latter three cases and it was found that, in general, the integrated absorption diminishes and the absorption maxima shifts towards higher frequencies with the rise of temperature. The radius of the rotating unit responsible for absorption of these ultra-high frequency radio waves has been calculated on Debye's theory and it is concluded that the molecules of these acids probably exist as dimers in the liquids. The absorption indices calculated from Debye's theory agree approximately with those observed in case of propionic acid and *n*-butyric acid, but wide divergence is found in the case of formic acid and acetic acid. A.

537.226.2

5765. Dielectric behavior at the second-order transitions in chromium sulphate, chromium nitrate, and nickel nitrate. H. GRAYSON-SMITH AND R. F. STURROCK. *Canad. J. Phys.*, **30**, 26–34 (*Jan.*, 1952).

In order to obtain further evidence concerning the nature of the second-order transitions which were discovered by Vasileff and Grayson-Smith in certain salts of the iron group metals [Abstr. 272 (1951)], dielectric measurements have been made at temperatures down to about 100°K. In the case of $Cr_2(SO_4)_3.18H_2O$ the transition at 195°K has a marked effect on the dielectric properties, which is clearly due to the freeing of polar molecular groups, so that they can be oriented by an electric field. The entropy of transition is close to $R \ln 4$, which suggests that two groups per molecule are set free, to take either of two quantized orientations. The dipole moment of the group which is set free can be estimated from the temperature dependence of the dielectric constant just above the transition point and has been found to be $2{\cdot}17\times10^{-18}$ e.s.u., approximately equal to the dipole moment of the H_2O molecule. It is likely, therefore, that the second-order transition in this salt is caused by the freeing of two of the 18 H_2O groups. For Cr and Ni nitrates the transitions have no observable effect on the dielectric properties, and it is suggested that in these salts NO_3 groups are set free. A.

537.226.2

5766. The dielectric properties of HBr and DBr in the solid state. J. G. POWLES. *J. Phys. Radium*, **13**, 121–33 (*March*, 1952) *In French.*

The real and imaginary parts of the permittivity have been measured for frequencies of 80 c/s–20 Mc/s over temperatures of about 60–100°K and the resul analysed by means of the Cole–Cole plot to separa the two mean relaxation frequencies in each cas In the higher temperature range the lower of the frequencies is unexpectedly lower for HBr than th for DBr. In the lower temperature range the activ tion energies corresponding to both the relaxatio show a sharp decrease for HBr but not for DB The latter behaviour is interpreted in terms of "tunnel effect" operative for dipolar rotations.

F. F. ROBER

537.226.2 : 536

5767. Thermodynamical theory of the ferro-electr phenomena in crystals of the type of barium titanat M. YA. SHIROBOKOV AND L. P. KHOLODENKO. *Z Eksper. Teor. Fiz.*, **21**, 1239–49 (*No.* 11, 1951) *Russian.*

Gives a complete thermodynamical theory of th ferroelectric phase transitions in crystals of the BaTiC type, considering all the invariants of the 6th orde and determining the tensor of the piezo-moduli d_i and that of the dielectric constant ε_{ik}. The investiga tion of the ferroelectric phases of a monocrystal cubic symmetry in the absence of an electric field an of elastic deformations is carried out by expandir the thermodynamic potential of the monocrystal in series in terms of the components of the polarizatio vector, discarding terms of higher than the 6th orde Solutions are found for cubic, tetragonal and ortho rhombic symmetry. The conditions of stability of th solutions found represent a minimum problem whic is also solved. In the determination of the coefficien of the expansion of the thermodynamical potenti special conditions have to be imposed, in order t exclude non-periodical infinite solutions witho physical meaning. Some simple relations a established between dielectric constants and piez moduli. B. F. KRA

537.226.2 : 536

5768. Ferroelectric characteristics of crystals of th type $BaTiO_3$ near the Curie point in the presence elastic stresses. L. P. KHOLODENKO AND M. Y SHIROBOKOV. *Zh. Eksper. Teor. Fiz.*, **21**, 1250–6 (*No.* 11, 1951) *In Russian.*

A further development of the paper reported in th preceding abstract which gave a thermodynamic theory of the ferroelectric characteristics of crysta which have cubic symmetry above the Curie poi [*Zh. Eksper. Teor. Fiz.*, **19**, 36 (1949)]. It is founde on Ginzburg's treatment of the ferroelectric phen mena by the general theory of phase transitions the 2nd kind. Consideration of 6th-order terms the expansion of the thermodynamic potential powers of the components of the polarization vector proves to be sufficient to interpret the observatio on phase transformations in a monocrystal of BaTiO In particular, limits of the values of the paramete corresponding to all possible equilibrium states of th crystal could be found. The experimental da relating to the electrostriction of the crystal, and the pressure relation of the Curie point, find a interpretation. The tensor of the dielectric constan in the presence of elastic stresses is calculated for wea fields. B. F. KRA

537.226.2 : 537.226.3

5769. Influence of a displacing field on the magnitude of dielectric permeability and dielectric losses in $BaTiO_3$. E. V. Sinyakov, E. A. Stafiĭchuk and L. S. Sinegubova. *Zh. Eksper. Teor. Fiz.*, **21**, 1396–1402 (*No.* 12, 1951) *In Russian.*

A constant displacing electric field decreases permittivity and tan σ in alternating fields, especially strongly in the ferroelectric range of temperatures approaching Curie point; it also increases Curie temperature. After-effects of displacing field indicate remaining anisotropic stresses in samples of polycrystalline $BaTiO_3$. Under action of a strong displacing field the polarization in an alternating field is mainly determined by inductive polarization. A displacing field, similarly to a constant mechanical loading, distorts the hysteresis loop. J. Lukaszewicz

537.226.2 : 621.3.011.5 : 621.317.335.3

5770. The dielectric constant of dry air. J. V. Hughes and H. L. Armstrong. *J. Appl. Phys.*, **23**, 501–4 (*May*, 1952).

A sensitive and accurate method for determining the real part of the permittivity of gases at microwave frequencies is described. The method eliminates some possible sources of systematic error inherent in earlier methods. The dielectric constant of dry air at N.T.P. has been determined as 1·000569, at a frequency of 3000 Mc/s. This is in good agreement with other results, at 24 000 Mc/s, at 9000 Mc/s and at low frequencies, thus verifying that the permittivity is independent of frequency up to nearly 30 000 Mc/s. An earlier result suggesting the contrary was found to be in error because of insufficient drying of the air. A.

537.226.3

5771. Anomalous dielectric loss in some of the alums. J. H. E. Griffiths and J. A. Powell. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 289–90 (*April*, 1952).

The variation of dielectric loss in the alums with wavelength (0·85 to 3·0 cm) and temp. (80–300°K) can be described by a single Debye loss curve; the exact value of the relaxation time and its temperature dependence is especially sensitive to the univalent cation. D. H. Whiffen

537.228.1 : 539.32

5772. Some measurements on barium titanate. H. Schmidt. *Akust. Beih., No.* 2, AB83–AB88 (1952) *In German.*

Formulae are given for circular piezoelectric disks from which it is possible to calculate the mechanical constants of the disk material from electrical measurements. The dependence of temperature upon dielectric constant, the electrical loss factor, elastic modulus, mechanical loss angle and the piezo-modulus of $BaTiO_3$ and the mixed ceramic $BaTiO_3$–$PbTiO_3$ have been measured, and are represented diagrammatically. The numerical value of the mechanical and electrical constants of $BaTiO_3$ are collected in a table. A.

537.228.1 : 621.3.012.8 : 621.396.611.21

5773. Measurement of the characteristics of a quartz crystal. J. Coulon. *C.R. Acad. Sci.* [*Paris*] **234**, 1269–71 (*March* 17, 1952) *In French.*

A simple valve circuit is used to obtain the equivalent circuit constants; the method is based mainly on the circular admittance diagram described earlier [Abstr. 4345 (1952)]. H. J. H. Starks

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3.08 : 539.152.2

5774. Determination of intense electric currents by nuclear magnetic resonance. G. J. Béné, P. M. Denis and R. C. Extermann. *Helv. Phys. Acta*, **24**, 633–5 (*No.* 6, 1951) *In French.*

The magnetic field of 500–800 gauss produced by a current of 4300–6400 amps in 11 turns of a helical coil 950 mm dia. and 500 mm long, is measured to 1 part in 10 000 or better from the nuclear resonance frequency of protons at the centre. The field/current factor may be calculated from the geometry, or measured using 20 amps, measured potentiometrically, in the coil and observing the frequency of the paramagnetic electron resonance of Na in liquid NH_3. D. H. Whiffen

537.3.08 : 578 : 621.317.715

5775. Contribution to the study of the moving-coil galvanometer of high voltage-sensitivity. Applications to several problems in biophysics. J. Coursaget. *Ann. Phys.* [*Paris*] **7**, 30–90 (*Jan.–Feb.*, 1952) *In French.*

Theoretical considerations include various cases. The moving-coil instrument is used on account of its low earth field effect, and for the ease of varying the damping electrically. Galvanometers by Moll and Hill are referred to and limits in sensitivity of existing types discussed. New developments include a "magneto-crystal," in which a very small paramagnetic crystal is fixed to the movement, providing no control at zero deflection: this is discussed fully. A typical instrument of this type had a voltage sensitivity of $\sim 10^{-8}$ V/mm at 1 m. Other instruments considered include the photocell type. Applications of these galvanometers include measurement of osmotic pressure. E. H. W. Banner

537.3.081 : 621.3.081

5776. Observation on the new definition of the ampere. R. Gans. *Ann. Phys.* [*Lpz.*] **10**, 167–9 (*No.* 3, 1952) *In German.*

An expression for the electrostatic force between the two parallel conductors involved in the definition is derived. The force can be neglected if the resistances are fractions of 1 Ω and tends to zero as the resistances tend to zero. Hence the insertion in the definition of the words "of infinitely large conductivity" is suggested in addition to "conductors of infinitely small dimensions." S. Weintroub

537.311.31

5777. On the theory of the electrical conductivity of metals. I. H. Koppe. *Z. Naturforsch.*, **7a**, 17–22 (*Jan.*); 156–61 (*Feb.*, 1952) *In German.*

A new method of treating transport phenomena in metals is developed and is suitable for highly degenerate Fermi gases. It is based on the attempt to abandon the usual method of solving the Boltzmann equation of state in which the distribution function (f) of electrons in the presence of an electric field is assumed to be a Fermi–Dirac function to which a perturbing term is added. In this paper the two main assumptions are (1) that there exists a surface S in k-space such that $f \sim 1$ inside S and $f \sim 0$ outside S (drop-shaped distribution), and (2) that the transition

region in which f changes has a thickness which corresponds to an energy of order kT. In the course of the calculation further important limitations (restriction to free electrons, small currents, etc.) must, however, be imposed. The hope is expressed that the theory can be applied to the calculation of electrical conductivities at low temperatures.

P. T. LANDSBERG

537.311.31

5778. Experiments on the electrical resistivity of metals. D. K. C. MacDonald. Letter in *Phil. Mag.*, **43**, 479–81 (*April*, 1952).

A Collins liquefier has been adapted for measurements of electrical conductivity of metals continuously from room temperature down to the liquid helium range. Measurements on Rb are reported and it is found that anomalies are observed above 170°K.

C. A. HOGARTH

537.311.31

5779. Scattering of electrons in metals by dislocations. D. L. Dexter. *Phys. Rev.*, **86**, 770–4 (*June* 1, 1952).

The problem of the change in electrical conductivity in metals upon cold-working is treated by the method of Koehler in which the scattering of electrons by pairs of parallel edge-type dislocations is assumed to be the major effect. A comparison is made between the electronic shielding assumed in the scattering potential used by Koehler and the shielding assumed by Landauer in a somewhat different treatment. The large effect of the discontinuity in the ionic displacement across the plane connecting the dislocation axes is shown to cancel that of a previously neglected term in the scattering potential. The scattering matrix element is evaluated, and the change in resistivity is computed by the perturbation method of Mackenzie and Sondheimer. Finally, the anisotropy in the resistivity is discussed, and it is shown that the slip direction is the direction of low resistivity.

A.

537.311.31 : 536.48

5780. Theory of the electric conductivity of metals, considering electron interaction. S. V. Vonsovskiĭ, K. B. Vlasov and A. V. Sokolov. *Zh. Eksper. Teor. Fiz.*, **21**, 1185–1200 (*No.* 11, 1951) *In Russian.*

Quantum-mechanical calculations were made of the temperature relation of metals near the absolute zero. They were based on a polar multi-electron model, in the approximation of "weak" polarization, enabling the method of "quasi-particles" (pairs and holes) to be used under the scheme of the kinetic equation. This approximation is important for "bad" metals, with a small number of conductivity electrons, the energy distribution of which has Bose character. The temperature relation of the conductivity so obtained ($\rho \sim AT + BT^2$) is very different from that resulting from the single-electron theory ($\rho \sim T^5$). In the low-temperature range investigated, two intervals have to be distinguished, $T \ll \Theta^2/\Theta'^\circ$ and $T \gg \Theta^2/\Theta'^\circ$ (Θ characteristic temperature of the crystals, Θ'° char. temp. of pairs or holes). In the first of these cases, $\rho \sim AT$, in the second $\rho \sim BT^2$. The boundary between these intervals is determined by relation between values of the Debye temperature and the temperature of degeneration of the pairs and holes. Although experimental data for comparison are scarce, those available do not contradict theoretical results.

B. F. KRAUS

537.311.31 : 537.312.6

5781. The high frequency resistance of metals in the normal and superconducting state. C. J. Grebenkemper and J. P. Hagen. *Phys. Rev.*, **86**, 673–4 (*June* 1, 1952).

The h.f. resistance of Pb, In and Sn has been measured at frequencies in the vicinity of 9000 Mc/s using resonant cavity techniques. Preliminary measurements on Sn at 24 000 Mc/s also have been made. The experimental techniques and measurement procedure are described. The effect of surface finishes is discussed for both the normal and superconducting regions. Data for the normal state are in general agreement with the Reuter–Sondheimer theory of the anomalous skin effect. The h.f. resistance in the superconducting region was found to vary with frequency as the three-halves power rather than the predicted variation of the second power.

537.311.31 : 538.22 : 538.63

5782. Electrical properties of the sodium tungsten bronzes. H. J. Juretschke. Letter in *Phys. Rev.* **86**, 124–5 (*April* 1, 1952).

To account for the resistivity, the Hall coefficient and the magnetic susceptibility of the materials Na_xWO_3, $x < 1$, a model is proposed in which Na is distributed uniformly in a cubic mesh within the WO under high (positive or negative) pressure. Values of these constants, calculated on the assumption that they are due to the Na in this condition, are shown to be in agreement with recently published results of measurement.

M. R. HOPKINS

537.311.3

5783. Influence of the surface levels on the chemical potential and the work function of a semiconductor. G. E. Pikus. *Zh. Eksper Teor. Fiz.*, **21**, 1127–3 (*No.* 11, 1951) *In Russian.*

The investigation is founded on the assumption that the surface states form a surface zone in which the number of levels is equal to the number of surface cells of the crystal. The influence of this zone on the relation between chemical potential and temperature and crystal dimensions, respectively, as well as on work function, contact phenomena and conductivity is studied. The fundamental equation of the problem is Poisson's equation involving the concentration of the holes in the populated zone, the concentration of the free donor levels, that of the acceptor levels and of the electrons in the conductivity zone. The great number of possible boundary conditions requires a subdivision of the investigation into many special cases which mostly offer no excessive mathematical difficulties. In greater detail are investigated the conditions at low temperatures, with a comprehensive discussion of available experimental results on conductivity at low temperatures which are compared with the author's theoretical results, conditions at medium and high temperatures, contact between semiconductor and metal, and the variation of the work function in electric fields.

B. F. KRAUS

537.311.33

5784. Electrical conductivity in the compounds PbS, PbSe, PbTe. E. H. PUTLEY. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 388–9 (*May*, 1952).

Measurements of Hall constant R, electrical conductivity σ, and mobility b, are reported for single-crystal specimens. Values for b at 290°K in cm²/volt sec are given as follows: (i) electrons, PbS 640, PbSe 1400, PbTe 2100; (ii) holes, PbS 800, PbSe 1400, PbTe 840. The forbidden gap is given as 1·17 eV for PbS and as 0·63 eV for PbTe.

C. A. HOGARTH

537.311.33 : 548.735.7

5785. Low temperature conductivity as a function of internal surfaces. I. SHAPIRO. Letter in *J. Chem. Phys.*, **20**, 923 (*May*, 1952).

Previous work of the author, with Kolthoff (1947, 1948) is quoted in criticism of a recent paper by Murphy [Abstr. 2245 (1952)] and the latter's conclusion, that the second term in the expression for the d.c. conductivity cannot be used as a measure of internal surfaces, is refuted. A. D. LE CLAIRE

537.311.33

5786. Positive current creep in selenium rectifiers. R. COOPER AND J. HARRINGTON. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 303–4 (*April*, 1952).

Evidence is provided which suggests that the explanation for positive creep in Se rectifiers based on power dissipation in the barrier layer, given by Henisch and Ewels [Abstr. 1055 (1951)], may not always be valid. C. A. HOGARTH

537.311.33

5787. *p–n* junction method for measuring diffusion in germanium. W. C. DUNLAP, JR, AND D. E. BROWN. Letter in *Phys. Rev.*, **86**, 417 (*May* 1, 1952).

A method in which radioactive Sb is made to diffuse into Ge thus forming a *p–n* junction within the crystal wafer. For two specimens values for D of $2{\cdot}1\times10^{-10}$ and $5{\cdot}5\times10^{-11}$ cm²/sec are found, the effect is a true volume diffusion effect, and the variation of D with temperature obeys the Langmuir–Dushman equation. C. A. HOGARTH

537.311.33

5788. On the diffusion theory of rectification. P. T. LANDSBERG. *Proc. Roy. Soc. A*, **213**, 226–37 (*June* 24, 1952).

It is pointed out that the Einstein relation $eD = vkT$ between the mobility (v) and the diffusion coefficient (D) of current carriers has not so far been established theoretically or experimentally for the case of rectifying junctions which are carrying a current. It is shown that the theory can be developed without appealing to this relation, so that experimental characteristics can be utilized to test for the validity of the Einstein equation. When this is done experiment suggests different values of v, D and v/D for forward characteristics from those it does for reverse characteristics. This result has been discussed, taking into account Fermi–Dirac statistics, in the light of the formal theory of conduction. This has been shown to lead (*a*) to the diffusion equation and (*b*) to a slight modification of Einstein's relation, provided v and D are regarded as averages for the barrier. Strictly, v and D depend on the concentration distribution of conduction electrons in the barrier. The shapes of the experimental curves are in agreement with theory. A.

537.311.33 : 621.314.63 : 621.314.7

5789. Contribution to the study of rectification and transistor phenomena in germanium. P. AIGRAIN. *Ann. Phys.* [*Paris*] **7**, 140–84 (*Jan.–Feb.*, 1952) *In French.*

An electronic arrangement for the study of the characteristics of crystal valves and associated contact devices is described. Results of the author together with those of the Bell Telephone Laboratories are discussed and existing rectifier and transistor theories are found to be inadequate. A theory is developed in which a rather thick surface inversion region (up to 10^{-3} cm) of opposite sign but gradually varying composition occurs. This region is probably formed through the absorption of O during the etching and subsequent anodic oxidation of the Ge. An appreciable superficial conduction would thus be expected and the ultimate seat of conduction would be at the *p–n* transition region well inside the material. The mathematical theory is developed and provides satisfactory agreement with the experimental facts, particularly those concerning current gain in Ge transistors. C. A. HOGARTH

537.311.62

5790. Skin effect in bar conductors of trapezoidal section in a ferromagnetic field. I. A. TYUTIN. *Latv. PSR. Zin. Akad. Vēst. No.* 3, 473–99 (1951) *In Russian.*

Calculation of the skin effect in trapezoidal bars and slots has hitherto been based on a rectangular approximation. Formulae derived from the true shape of the slots, involving Bessel functions, are obtained, and compared with the rectangular approximations. These results, in the form of charts and formulae convenient for practical use, as well as further work on skin effect theory, are to appear in subsequent articles. F. QUELON

537.312.5 : 535.215.4

5791. The behaviour of Cs–Sb photocathodes at various temperatures. N. SCHAETTI AND W. BAUMGARTNER. *Helv. Phys. Acta*, **24**, 614–19 (*No.* 6, 1951) *In German.*

On cooling, the long wave threshold shifts towards the shorter wavelengths of the spectrum. Saturation is reached at lower voltages for lower temperatures. The conductance of the photocathodes shows the characteristic of semiconductors (a kink in the graph of the conductance). W. SUMMER

537.312.5 : 539.21

5792. On the surface photoelectric effect in alloys during the ordering process. A. V. SOKOLOV. *Zh. Eksper. Teor. Fiz.*, **21**, 1384–8 (*No.* 12, 1951) *In Russian.*

Investigates the effect of the degree of long-range order on photoelectric emission and the effective yield work for a binary alloy during the ordering process. The relationships are derived on the basis of theory suggested by Smirnov (1947) and dealing with the motion of an electron in the crystal lattice

of an alloy having any composition and any degree of long-range order. For the case of frequencies near the limiting value, both the photoelectric current and the effective yield work have been found to be functions of the degree of long-range order. It is concluded that photoelectric properties of alloys during their ordering ought to display "ordering anomalies," e.g. a photoelectric current anomaly should occur when the Curie point is passed. It is pointed out that the relationships and equations developed are based on a rather simplified alloy model and so can hardly give the quantitative picture of the phenomena involved.

F. LACHMAN

537.312.62

5793. The superconducting cylinder and sphere in a magnetic field. V. P. SILIN. *Zh. Eksper. Teor. Fiz.*, **21**, 1330–6 (*No.* 12, 1951) *In Russian.*

The magnetic behaviour of a superconducting cylinder and sphere are re-examined according to the theory of Ginsburg and Landau [Abstr. 1017 (1952)]. For small fields the formulae for χ/χ_0 become in the limiting cases of "small" and "large" specimens identical with those obtained from the London theory. For destruction of superconductivity a critical size is found in each case below which the transition becomes of the second rather than the first order. The destruction of superconductivity of thin wires by a current is also briefly discussed. D. SHOENBERG

537.312.62

5794. Superconductivity and resistance of tin with lattice faults. W. BUCKEL AND R. HILSCH. *Z. Phys.*, **131**, 420–42 (*No.* 3, 1952) *In German.*

See also Abstr. 319 (1951). The superconducting transition temperature T_c of Sn films evaporated on quartz and other surfaces was investigated for different temperatures, T, of the surface and different thickness. It was found that T_c increased from its "bulk" value 3·7°K for $T = 290$°K to about 4·6°K for $T = 6$°K [See also Shalnikov, *Nature* [*Lond.*] **142**, 74 (1938)]; there was no very marked influence of thickness or substrate. Some experiments on the effect of cold working bulk Sn at low temperatures confirmed the results of Lasarev and Galkin (1944) that T_c can be considerably raised also by the lattice distortion produced by cold work. D. SHOENBERG

537.312.62

5795. Bardeen's theory of superconductivity and the *f*-sum rule. E. N. ADAMS, II. Letter in *Phys. Rev.*, **86**, 258 (*April* 15, 1952).

It is shown that on Bardeen's model the Landau–Peierls susceptibility is actually paramagnetic and would not, therefore, keep out the magnetic field.

H. LONDON

537.312.62 : 536.631

5796. Behavior of the heat capacity of superconducting niobium below 4·5°K. A. BROWN, M. W. ZEMANSKY AND H. A. BOORSE. Letter in *Phys. Rev.*, **86**, 134–5 (*April* 1, 1952).

C_s and C_n, the molar heats in the superconducting and normal state, were measured between 2·5° and 20°K. Below 4·5°K the points for C_s fall below $464(T/161°)^3$, which otherwise represents the results. $C_n = 21·0\times10^{-4}T + 464(T/254°)^3$ is followed up to 12°K. The calculated threshold field at absolute zero is 1960 gauss and the critical temperature 8·7°K.

H. LONDON

537.312.62 : 536.3

On the thermodynamics of a Fermi gas with exchange. *See Abstr.* 5751

ELECTRIC DISCHARGES 537.52

537.523.3

5797. The effects of argon and argon-helium mixtures on the direct current arc. B. L. VALLEE AND S. ADELSTEIN. *J. Opt. Soc. Amer.*, **42**, 295–9 (*May*, 1952)

The use of argon as an environment for the d.c. arc results in marked prolongation of volatilization, increased initial electrode currents and enhancement of lines of many elements, particularly volatile ones, when samples are burnt to extinction and compared to helium and argon-helium mixtures. An interdependent relationship between total time necessary for complete volatilization of samples, percentage helium and argon composition of the atmosphere and sample concentrations is demonstrated. Independently, a relationship between the electrode current per cent helium and argon, and concentration of the sample exists. A

537.523.5 : 537.525.5

5798. Calculations on electrode-stabilized arc discharges. G. SCHMITZ. *Z. Phys.*, **132**, 23–9 (*No.* 1, 1952) *In German.*

Discusses plasma balance equations for arcs in which electrodes are important, with special reference to spatial variations of the temperature of such discharges. J. D. CRAGGS

537.523.5 ; 621.066.6 : 621.316.5.064.2

5799. Arcing at electrical contacts on closure. III Development of an arc. L. H. GERMER AND J. L. SMITH. *J. Appl. Phys.*, **23**, 553–62 (*May*, 1952).

For Pt II, see Abstr. 9507 (1951). A description is given of a system made up of experimental electrodes and an oscilloscope by means of which the potential across the electrodes can be recorded with a time resolution of about 10^{-9} sec and a potential sensitivity of 1 trace width per volt. The closure of the electrodes to produce a short arc is synchronized with the oscilloscope sweep so that the beginning of the arc is photographed. As an arc starts, the potential across the electrodes decreases more or less gradually from the applied voltage to a steady value characteristic of the metal of the electrodes. The course of this change is extremely variable, as is also the time over which the change is spread. The average value of the time appears to vary with circuit inductance and with the nature of the electrode surfaces. For inactive silver surfaces and an inductance of 0·10 μH the average value of the time is about 0·007 μsec, and for active surfaces and the same inductance 0·011 μsec. For active surfaces and an inductance of 5 μH the average value of the time is 0·02 μsec. The electrode separation at which an arc strikes is determined from the oscilloscope traces and from a correction for the

height of the mound of metal thrown up by the arc. For active silver electrodes the average separation (at 40 or 45 V) corresponds to a gross electric field of $0{\cdot}8\times10^6$ V/cm, and for inactive silver electrodes to a field of $2{\cdot}3\times10^6$ V/cm. These are probably better values than earlier measurements of these fields. There has not yet been any success in interpreting these phenomena in terms of fundamental processes. A.

537.525

5800. Oscillographic method of investigation of gas discharges with the aid of probes. A. M. Bonch-Bruevich. *Dokl. Akad. Nauk SSSR*, **81**, 371–4 (*No.* 3, 1951) *In Russian.*

In studying gas discharges, the usual procedure of obtaining a number of points on the characteristic curve, is limited to steady discharges. A simple oscillographic method of observing the probe characteristic, permitting rapid and accurate determination of the discharge parameters, is described. A recurrent impulse is fed to the probes through a resistor, across which is connected a c.r.o. with a sweep following the probe potential according to a logarithmic law, the time constant of which is adjusted to produce a straight line on the c.r.o. screen. Electron-temperatures can be arranged to be read off directly on a scale. The energy of electrons emitted by a hot cathode, measured by the method, agreed to within 3–5% with the calculated value.

F. QUELON

537.525

5801. Joshi-effect and the h.f. components. G. V. Bakore. *Indian J. Phys.*, **25**, 274–6 (*June*, 1951).

The theory of the Joshi-effect proposed by Deb and Ghosh (1948) is shown to be inadequate. It is pointed out that the occurrence of both the positive and the negative Joshi-effect is possible on Joshi's theory consistent with the findings of Klemenc, Hinterberger and Hoffer (1937). A.

537.525

5802. Drift velocity of electrons in argon and argon mixtures. J. M. Kirshner and D. S. Toffolo. *J. Appl. Phys.*, **23**, 594–8 (*May*, 1952).

Since A is prepared by fractional distillation from liquid air, the greatest impurity found in it is N, whose boiling-point lies close to that of A. For this reason it is believed that some of the previous measurements on supposedly pure A were actually made on N-contaminated A. By adding controlled amounts of N to pure A, the drift velocity curves of various authors can be duplicated. A.

537.525 : 621.3.015.5

5803. The initiation of electrical breakdown in vacuum. L. Cranberg. *J. Appl. Phys.*, **23**, 518–22 (*May*, 1952).

The hypothesis is suggested that initiation of high voltage breakdown in vacuum is due to traversal of the high voltage gap by a clump of loosely adhering material. The implication of this hypothesis for uniform-field gaps is that the breakdown voltage is proportional to the square root of the gap length. A summary of the literature is presented which supports this conclusion for a range of voltages from 20 kV to 7 MV, and for a range of gap distance from 0·2 mm to 6 m. Additional qualitative evidence is presented which tends to support the proposed hypothesis. A.

537.525.3 : 537.525.8

5804. On the transition region between self-sustained and unselfsustained discharges in gases. W. Kluge. Note in *Naturwissenschaften*, **39**, 186 (*No.* 8, 1952) *In German.*

A brief note discussing the transition region, in low-pressure gaseous breakdown, between the Townsend discharge ("dark current regime") and the selfmaintained glow discharge. J. D. CRAGGS

537.525.4

5805. On the sparking criterion of high frequency [breakdown]. K. Honda. *Japan Sci. Rev.*, **1**, 64–8 (*March*, 1949).

Describes the development of a simple theory of gaseous electrical breakdown for uniform fields and for frequencies (say 3–50 Mc/s) such that electrons and ions are trapped in the interelectrode space. The pressure was $\sim$ a few mm Hg. A satisfactory comparison with exptl. data is drawn. J. D. CRAGGS

537.525.4

5806. Electrical breakdown of gases. I. Spark mechanism in air. F. Llewellyn Jones and A. B. Parker. *Proc. Roy. Soc. A*, **213**, 185–202 (*June* 24, 1952).

From experimental investigations on ionization currents and high-voltage sparking in uniform electric fields it has generally been assumed that the growth of pre-breakdown currents followed a simple exponential law involving no secondary ionization, and that therefore to account for critical breakdown it was necessary to assume the sudden introduction of a new ionization mechanism not related to the growth of initial pre-breakdown currents. These data are critically analysed, and it is shown that they do not in fact preclude the existence of important secondary ionization, as was assumed. The experimental conditions which must be satisfied in order to reveal and measure any such secondary ionization are discussed, and a high-voltage ionization chamber designed and built to satisfy these conditions is described. Measurements of pre-breakdown ionization currents between parallel plates in air under conditions which include those corresponding to a 1 cm gap in the atmosphere ($E/p = 40$; $pd = 800$; $V_s = 30$ kV) showed that, while the growth of the currents was simply exponential over the greater part of the sparking distance, in the important region near breakdown itself the currents did, in fact, increase at the faster rate represented by

$$I = I_0 \exp(\alpha d)/[1 - (\omega/\alpha)\{\exp(\alpha d) - 1\}]$$

This indicates the existence of a secondary mechanism throughout the complete breakdown process. Furthermore, the measurement of the ionization coefficients α and (ω/α) in the early stages of the growth of a small ($\simeq 10^{-14}$ A) photoelectric current can predict, within the experimental error, the static potential at which the gas breaks down, thus indicating that the mechanism of the spark itself was the same as that which led to the growth of the photo-current even in its early stages. A.

537.525.4

5807. Electrical breakdown of gases. II. Spark mechanism in nitrogen. J. Dutton, S. C. Haydon and F. Llewellyn Jones. *Proc. Roy. Soc. A*, **213**, 203–14 (*June* 24, 1952).

The growth of pre-breakdown ionization currents I in uniform fields in nitrogen has been measured over a range of the spark parameters E/p from 41 to 45 V/cm mm Hg and pd up to 810 mm Hg cm with sparking potentials up to 38 kV, where p is the gas pressure and d the electrode separation. The graphs of log I against d were initially linear, but at separations near the sparking distance the graphs curved upwards, indicating the existence of both primary α and secondary (ω) ionization mechanisms. The sparking potentials and distance here measured were found to be exactly in accordance with those predicted by the growth of current equation

$$I = I_0 \exp(\alpha d)/[1 - (\omega/\alpha)\{\exp(\alpha d) - 1\}]$$

There were strong indications that the secondary ionization was, in fact, a cathode process. Possible effects of space charge were also considered, and the spark mechanism discussed. A.

537.525.4 : 537.53

5808. Short duration afterglow of nitrogen in the photographic infra-red. R. Herman, L. Herman and G. Hepner. Letter in *Phys. Rev.*, **86**, 570–1 (*May* 15, 1952).

The spectra of pulsed discharges in He N_2 mixtures at a total pressure of 5 mm were studied with a rotating disk stroboscope so that emission from the current-carrying discharge could be separated from that in the afterglow. Bands with higher excitation energies tend to disappear less in the afterglow than systems with lower excitation energies. J. D. Craggs

537.525.5 : 537.525.8 : 537.542

5809. Clean-up of helium gas in an arc discharge. M. J. Reddan and G. F. Rouse. *Trans. Amer. Inst. Elect. Engrs*, **70**, 1924–9 (*Pt II*, 1951).

For abstract, see Abstr. 4377 (1952).

537.525.8

5810. Operating characteristics of a water-cooled hollow cathode discharge, in air or argon at low pressures. J. Roig and M. Bécart. *C.R. Acad. Sci.* [*Paris*] **234**, 1606–8 (*April* 16, 1952) *In French.*

Gives i/v characteristics for air over a pressure range of 0·14–0·93 mm Hg, for currents of 35–80 mA and 370–560 V. In argon, a similar range of parameters was covered. Degassing at the cathode is briefly discussed. J. D. Craggs

537.525.8 : 537.525.5

5811. Low pressure mercury discharges. G. Meister and T. H. Heine. *Illum. Engng* [*N.Y.*] **47**, 159–64 (*March*, 1952).

Certain characteristics of low pressure Hg/Kr/Xe arcs were studied, up to gas filling pressures of about 5 mm for tube wall temperatures ~45°c, and for various Kr/Xe ratios. The data include discharge voltages and luminous efficiencies. Some experiments with fluorescent tube coatings were carried out. J. D. Craggs

537.525.8 : 537.525.5

5812. The mechanism of the low-frequency electrodeless discharge in chlorine and the influence of irradiation. A. K. Saha and M. Ghosh. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 304 (*April*, 1952).

A brief discussion of the discharge mechanisms in ozonizer tubes, with particular attention to the photodissociation of Cl molecules.

537.525.8 : 537.525.5

5813. Influence of irradiation on the low frequency electrodeless discharge in chlorine: negative Joshi effect. H. J. Arnikar. Letter in *J. Chem. Phys.*, **20**, 917–18 (*May*, 1952).

Comments on the work of Harries and von Engel [Abstr. 5436 (1951), 1029 (1951)] on the effect of irradiation, with visible light, of certain discharges, and gives 38 references on the Joshi effect. J. D. Cragg

537.525.8 : 537.525.5

5814. Influence of irradiation on the low frequency electrodeless discharge in chlorine: negative Joshi effect; a reply. W. L. Harries and A. von Engel. Letter in *J. Chem. Phys.*, **20**, 918 (*May*, 1952).

See preceding abstract.

537.527.4

5815. On the spectroscopic investigation of impulse condenser discharges in mercury [vapour] at the highest pressures. J. Euler. *Z. angew. Phys.*, 82–8 (*No.* 3, 1952) *In German.*

Describes spectroscopic methods of measuring temperatures in the Osram Type HBO200 lamp, giving data on line widths and on the continuous spectrum. Spectra are given for d.c. excitation and for condenser (spark) discharges in the same lamp. In the latter case, time-resolved spectra were studied with a rotating mirror spectrograph system. J. D. Cragg

537.527

5816. The measurement of radiation from a high pressure a.c. mercury arc for wavelengths in the tenth millimetre region. H. Säufferer. *Z. Phys.*, **131**, 376–84 (*No.* 3, 1952) *In German.*

Describes measurements made with a stroboscopic system of the radiation in the visible region and that of wavelengths $\sim \frac{1}{10}$ mm. For the latter a thermal detector was used, with a suitable filter system to intercept unwanted radiations. J. D. Cragg

537.527

5817. On the theory of the emission and absorption in high pressure arcs, of radiation in the tenth-millimetre region. G. Hettner. *Z. Phys.*, **131**, 385–9 (*No.* 3, 1952) *In German.*

Discusses, in the light of Unsöld's theoretical work on free–free transitions of an electron in the field of a positive ion, the emission of continuous radiation ($\lambda \sim \frac{1}{10}$ mm), particularly for h.p. mercury arcs. The data of Säufferer (preceding abstract) are treated. J. D. Cragg

537.527.5 : 536.5

5818. Measurement of the radial temperature variations in very high pressure mercury arcs from the peak intensities of self-absorbed spectral lines. W. Göing. *Z. Phys.*, **131**, 603–18 (*No.* 4, 1952) *In German.*

Applies the method of Bartels [Abstr. 2717 (1951)]

which involves measurements on self-absorbed spectral lines, to the study of temperatures in the Osram HBO200 lamp. The axial temperature was about 8000°K with an accuracy of measurement for individual lamps of about ±200°K. Data are given for the lines 4047, 4358 and 5461 Å and axial temperatures deduced from these three lines for any lamp agreed to within 80°K at ~ 8000°K. J. D. CRAGGS

537.529

5819. Theory of electric breakdown of solid dielectrics. A. A. VOROBEV AND E. K. ZAVADOVSKAYA. *Dokl. Akad. Nauk SSSR*, **81**, 375–7 (*No.* 3, 1951) *In Russian.*

Relationship between dielectric stress and lattice energy (work needed to split a crystal into gaseous ions at absolute zero temp.) is investigated. Under electric breakdown of alkali-halide crystals splitting of the lattice into ions in the breakdown path occurs. Relationship of time of dielectric breakdown and stress is also considered. J. LUKASZEWICZ

537.529

5820. Mechanical stresses in dielectrics under electrical breakdown. E. K. ZAVADOVSKAYA. *Dokl. Akad. Nauk SSSR*, **81**, 541–3 (*No.* 4, 1951) *In Russian.*

Electric loading stresses dielectrics mechanically. Electric strength can be decreased by mechanical stressing and can be increased with increase in mechanical strength. High dielectric permeability results in high mechanical stresses in electric field and also in decrease in dielectric strength.

J. LUKASZEWICZ

537.529

5821. The electric breakdown of alkali halide crystals. J. H. CALDERWOOD, R. COOPER AND A. A. WALLACE. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 301–2 (*April*, 1952).

Disagreement between various published results of the authors and of other workers is believed to be due to mechanical strains in specimens. Annealing the specimens before testing tends to yield more regular results. C. A. HOGARTH

X-RAYS 537.531

537.531 : 535.33 : 541.57

5822. X-ray spectrum and chemical bonds. The Kα-fluorescence spectrum of sulphur. A. FAESSLER AND M. GOEHRING. *Naturwissenschaften*, **39**, 169–77 (*No.* 8, 1952) *In German.*

Rules are found for the influence on the shift of the $K\alpha$-lines of S, (*a*) of the valency of S, (*b*) of the surrounding group of complex compounds, (*c*) of the ions bound to S of low valency. These rules are used for the determination of structure of formaldehyde sulphoxylate, S nitrides and organic S compounds. C. TURNER

537.531 : 535.34

5823. Absorption of 2 MeV constant potential roentgen rays by lead and concrete. W. W. EVANS, R. C. GRANKE, K. A. WRIGHT AND J. G. TRUMP. *Radiology*, **58**, 560–7 (*April*, 1952).

Transmission curves through Pb, Cu and concrete are given for an X-ray beam generated at 2 MeV constant potential. The variation of the curves with width of the beam is investigated and a comparison made of the half-value layers in these materials with those given by the γ-rays from Ra and Co.

H. MILLER

537.531 : 535.343

5824. Notes on the technique for studying *K* spectra of aluminium. Y. CAUCHOIS. *Acta Cryst.*, **5**, 348–50 (*No.* 3, 1952) *In French.*

An account is given of improvements to a previously described vacuum bent-crystal spectrograph for soft X-rays. The special features necessary for studying Al *K* spectra are the use of crystals of mica or of gypsum (free from Al), and the replacement of the usual Al window either by thin Li foils (down to 0·01 mm thick) or by butterfly wings. Be foils at present available are still too thick for use as windows, except for studying Al-rich samples. A.

537.531 : 535.343

5825. Comparative study of the *K* absorption spectrum of metallic aluminium. Y. CAUCHOIS. *Acta Cryst.*, **5**, 351–6 (*No.* 3, 1952) *In French.*

This was studied with the help of the focusing spectrograph and experimental technique previously described (preceding abstract). The results agree with those of Sandström except for new details close to the main edge; this now appears to be narrower and more similar to the emission edge. New absorption bands have been measured down to 190 eV from the edge. Their interpretation is given according to Kronig's theory for electrons travelling in the Al crystal. They are compared both with the *L* absorption bands of Al and with the *K* bands of two other metals with close-packed cubic structure, namely Ni and Cu. It is then shown that discrete energy losses for electrons travelling in Al, as observed by Rutheman with a magnetic spectrometer for slow electrons crossing very thin Al foils, are in good agreement with the band scheme deduced from the present experiments. A.

537.531 : 535.43 : 532.7

5826. The application of Fourier analysis in the interpretation of X-ray diffraction photographs of liquids and vitreous substances. M. I. PETRASHEN AND E. A. PORAĬ-KOSHITS. *Zh. Eksper. Teor. Fiz.*, **21**, 887–93 (*No.* 8, 1951) *In Russian.*

Analysis of the fundamental formula of the theory of the scattering of X-rays by liquids and glasses, which relates the intensity of the scattering to the atomic distribution function, demonstrates that even for one kind of atom the results of the formula are based on the assumption of a disordered atomic distribution. Application of the formula to polyatomic substances, its transformation by means of Fourier's theorem, and also its use in the theory of small-angle scattering introduce further averages and simplifications which lessen the value of conclusions reached by Fourier analysis as to the structure of liquids and glasses. Hence the results of Warren (1937) apparently confirming the disordered lattice

and quasicrystalline hypothesis do not follow as unique conclusions of a strict mathematical analysis but are only one possibility obtained on the basis of qualitative crystal-chemical considerations.

A. L. MACKAY

CATHODE RAYS. POSITIVE RAYS 537.533/.534

537.533 : 537.534

5827. Production of a flat pencil of electrons. Application to the mass spectrometer. R. VAUTHIER. Letter in *J. Phys. Radium*, **13**, 107–8 (*Feb.*, 1952) *In French.*

537.533.72

5828. Caustic surfaces of electron lenses. V. GLAZER [W. GLASER] AND G. GRYUMM [GRÜMM]. *Zh. Tekh. Fiz.*, **21**, 1412–26 (*No.* 11, 1951) *In Russian.*

Finsterwalder's method (1892) of determining the shape and position of the caustic surfaces [surfaces of maximum intensity] due to the combined Seidel aberrations in the imaging of an off-axis point is applied to e.s. and magnetic lenses. It is shown how the formulae must be modified when there is no stop. Numerical values of parameters and photographs of models of the caustic surfaces are given for one set of typical electron microscope objective data, using the "bell" field. J. C. E. JENNINGS

537.533.72

5829. A wave mechanical determination of the intensity relations in the image space of electron lenses. I. Determination of the electron intensity for given geometrical-optical imagery. V. GLAZER [W. GLASER] AND G. GRYUMM [GRÜMM.] *Zh. Tekh. Fiz.*, **21**, 1427–43 (*No.* 11, 1951) *In Russian.*

By an extension of the WKB method, Schrödinger's equation is shown to lead, for a slowly varying refractive index, to corrections of the amplitude and phase as compared with the usual solution for locally constant refractive index; the conditions of validity of these corrections are shown to hold in existing electron microscope lenses. The corrected solutions are to be applied to rotationally symmetric systems having Seidel aberrations and also to systems with imperfect rotational symmetry. J. C. E. JENNINGS

537.533.72

5830. Movement of charged particles in the magnetic field of a linear current and the electric field of a cylinder capacitor. V. M. KALMAN AND I. V. RODNIKOVA. *Zh. Eksper. Teor. Fiz.*, **21**, 1364–9 (*No.* 12, 1951) *In Russian.*

The Hamilton–Jacobi differential equations of the non-relativistic problem of the movement of a charged particle in a constant electromagnetic field (cylinder capacitor and current-carrying conductor along its axis) permit of solutions in the form of quadratures. For certain relations between field strength and initial particle velocities such a system has the property of focusing beams of charged particles. It is shown that a linear, current-carrying, conductor acts on the movement of charged particles the initial velocities of which are at right angles to the conductor as a deflecting electron-optical element. It has in this respect much in common with a shor magnetic lens, and the simplest magnetic lens is conductor bent into a ring. The deflection of thi linear conductor then becomes a focusing into thi axis of the ring. The displacement parallel to thi current may be compensated by the methods use with magnetic lenses for compensating image rotation The deflecting systems must for this purpose consis of two linear and parallel conductors carryin opposing currents. The great advantage of thi deflecting systems considered in the paper over thi known types is that their characteristics do not chang in a direction parallel to the current. Therefore suc systems do not impose any limitations on the heigh of the beams to be deflected as do all the usua deflecting systems owing to the leakage fields at thi edges of the poles. B. F. KRAU

537.533.7

5831. A new mathematical model of an electron len P. GRIVET. *J. Phys. Radium*, **13**, 1A–9A (*Feb. Suppl* 1952) *In French.*

A fuller version of Abstr. 1051, 3629 (1952 $[H = H_0 \operatorname{sech}(z/b)]$, giving some comparisons wit experiment. It is shown in an appendix ho $P_\nu(\cos\theta)$ may be computed for ν not integral c half-integral. J. C. E. JENNINC

537,533.7

5832. Trajectories in electron lenses: a method c approximation. F. BERTEIN. *J. Phys. Radium*, 1 41A–49A (*Feb. Suppl.*, 1952) *In French.*

Paraxial rays are assumed to have the form of polynomial in z (the axial co-ordinate), the coefficien being determined by a method which requires th evaluation between fixed limits of $\int v z^n dz$, where v the potential function and n takes various integra values. Although the method is discussed wit reference to electrostatic lenses, it is equally applicab to magnetic ones. J. C. E. JENNINC

537.533.7

5833. A β-spectrograph having a plane of symmetr and double [= stigmatic] focusing, using iron-fre coils. A. MOUSSA AND J.-B. BELLICARD. *C.R. Aca Sci.* [*Paris*] **234**, 1681–3 (*April* 21, 1952) *In French.*

In the median plane between 2 like coaxial circula conductors $H_z\sqrt{r}$ is stationary at one r, which varie with coil separation. If their dimensions and amper turns are suitably chosen, 2 pairs of coils can giv $H_z\sqrt{r}$ nearly constant over a wide range of Numerical data are given for 2 suggested system An instrument is under construction capable c focusing 1·3 MeV electrons, using 3·6 kW. T expected resolution is $\Delta Hp/Hp = 1{\cdot}2\%$ at 0·84 of 4π. J. C. E. JENNINC

537.533.72 : 539.166.8

5834. The construction and testing of a magnet prism β-spectrograph of high resolution, with a note c the reported fine-structure of certain internal conversio lines of RaC.C′. R. E. SIDAY AND D. A. SILVERSTO *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 328–44 (*May*, 1952).

The first set-up of a very simple high resolutio β-spectrograph is described. The instrument employ the focusing action of a magnetic prism with circul plane poles of 20 cm dia. For this area of po surface the dispersion is large, giving advantage t

the width of source that may be used; and the instrument can focus electrons with energies up to 4 MeV. It has been used with resolving powers $H\rho/\Delta(H\rho)$ up to 1300 as measured from microphotometer traces on the plates. It appears to be the only instrument that has been operated at these resolutions as a spectrograph. As a β-spectrometer, the resolving power should be 15% higher, but this has not yet been tested. As far as can be seen it has a luminosity roughly comparable with that of the ketron, but unlike that instrument it has considerable flexibility of experimental arrangement promising improved performance. It has been used to look for the fine structure of the K-conversion line corresponding to the 1414 keV γ-transition in the disintegration RaC.C′ reported by Latyshev and others. In agreement with the work of Bashilov and others who employed the ketron, and of Serebriskaya, Shpinel and Forafontov who used a spectrometer of completely novel design, this line was found to be highly monokinetic. A.

537.533.73

5835. A substitution apparatus for electron diffraction at grazing incidence. F. HEISE. *Optik*, **9**, 139–42 (*No.* 3, 1952) *In German.*

Describes a fitting which allows the AEG-Zeiss type EM8 microscope to be used for electron diffraction studies at grazing incidence. An ion source is used to eliminate unwanted charges in the vicinity of the object. A. H. W. BECK

537.533.74

5836. Influence of the electron exchange on the non-elastic electron scatter in metals. A. YA. VYATSKIN. *Zh. Eksper. Teor. Fiz.*, **21**, 1350–3 (*No.* 12, 1951) *In Russian.*

See also Abstr. 8791 (1950). The influence of the electron exchange on the differential coefficient of damping, and therefore on the differential cross-section of scatter, is investigated. It is natural to assume that the beam of non-elastically scattered electrons is not polarized, so that the wave function of the system of two interacting electrons must be a combination of a symmetrical and an antisymmetrical function. The wave function for a system of two electrons involves the co-ordinates of the scattered and the lattice electron. The antisymmetrical function contains a term expressing the law of conservation of the impulse. As a result it is seen that the electron exchange increases the effective cross-section of scatter by 10%. The angular distribution of the scattered electrons is affected even more by the exchange. If two of the terms of the final expression are discarded, we obtain Rutherford's formula for the scatter of α-particles in the Coulomb field of the nucleus. Both effects increase at large angles, the difference being that instead of an infinite increase of the diff. cross-sect. for $\theta \to \pi/2$, the diff. cross-sect. will here approximate a finite value, and, furthermore, for some intermediate value of θ, $0 < \theta < \pi/2$, where the resonance condition $\overline{K}' = K \cos\theta j = (\overline{k} + 2\pi\overline{n}/a)$ is satisfied, the diff. coefficient of damping and diff. cross-sect. of scatter become ∞. B. F. KRAUS

537.533.74

5837. Single scattering of fast electrons through large angles. W. PAUL AND H. REICH. *Z. Phys.*, **131**, 326–30 (*No.* 3, 1952) *In German.*

The relation between single scattering of 2·2 MeV electrons from a betatron through large angles (60°, 90° and 120°) and the atomic number of the scattering substance was investigated. The scattering cross-section of heavy elements for angles above 60° is smaller than predicted by the Mott–Feshbach theory, but is in agreement with the theory for the lighter elements. J. A. FRANKS

537.533.75

5838. On the range of fast electrons. O. BLUNCK. *Z. Phys.*, **131**, 354–75 (*No.* 3, 1952) *In German.*

The range distribution of fast electrons within a material is investigated for incident energies which are large or small compared with the electron rest-mass. Pearson's method is used to calculate the range distribution from the mean power values of the range. A simple expression is obtained for the average range, the most probable and maximum ranges can be read from the distribution curve. A good agreement with experiment is obtained for the range distribution of 20 kV electrons in O_2. The variation of range distribution of high-energy electrons with incident energy is discussed for Pb and O_2.

J. A. FRANKS

537.533.8

5839. Secondary electron emission at high current densities. D. A. JENNY. *Diss. E.T.H., Zürich, No.* 1989, 78 *pp.* (1951).

A qualitative theoretical picture of the processes and conditions determining the multiplication ratio, δ, of a composite secondary electron emitter, based on the excess metal emission concept proposed by Suhrmann and Berger [Abstr. 2860 (1948)] is described. This theory is capable of explaining the experimental work described as well as the majority of previously published results. The experimental production, with special consideration of practical applications, of a magnesium and barium oxide (molar mixture ratio of 4 : 1) secondary emitting surface capable of maintaining a $\delta \sim 4$ at a primary energy of 300 V with a secondary current density of 2 amp/cm², for several hundred hours without δ decay is described. Details of the controls required to prevent δ decay are given. H. P. MYERS

537.533.8

5840. Theory of the production of secondary electrons in solids. A. J. DEKKER AND A. VAN DER ZIEL. *Phys. Rev.*, **86**, 755–60 (*June* 1, 1952).

On the assumption of a simple Coulomb interaction between a primary and a lattice electron, a general formulation of the problem of the production of secondary electrons is given. The basic features of the existing theories of secondary emission are presented and discussed as different approximations of this formulation. Special attention is given to the process of production of secondaries and to the energy losses suffered by the bombarding primaries. Finally, the ratio is estimated of the number of secondary electrons emitted due to processes considered by Wooldridge and those investigated by Baroody. A.

537.534

5841. A laboratory mass spectrometer with many uses. G. PHILBERT, with the collaboration of R. VALENTIN. *J. Phys. Radium*, **13**, 50A–58A (*Feb. Suppl.*, 1952) *In French.*

The spectrometer and its associated electronic

circuits are described. It is characterized by the relatively high gas pressure, $\sim 10^{-2}$ mm, used in the ion source, the ease of modifying and replacing the ion source, and the facilities for investigating ion optics. J. HUGHES

537.534 : 621.384.82

5842. A linear radio-frequency mass spectrometer. P. A. REDHEAD. *Canad. J. Phys.*, **30**, 1–13 (*Jan.*, 1952).

The mass spectrometer uses a system of electrodes similar to a linear accelerator to obtain velocity selection of tin ions. A beam of ions is directed through a series of axial radio-frequency fields with alternate polarity, and the ion with a velocity (proportional to $M^{-\frac{1}{2}}$) such that it traverses the individual stages in approximately one-half period of the radio-frequency field, acquires maximum energy from this field. A retarding field region prevents all ions, except the ion with maximum energy, from reaching the collector. An ion beam of large cross-section is used. With 20 radio-frequency stages a mass resolution of 1% is obtained. A.

537.534.72

5843. Mass spectrometry, measurement and recording of ion currents. R. BONNE AND R. MARGOLOFF. *Ann. Radioélectricité*, **6**, 318–35 (*Oct.*, 1951) *In French.*

The current measurement and recording system of the C.S.F. spectrometer is described and discussed. A digest of relevant literature is included (26 references). J. J. WILKINS

537.534.72

5844. Image errors in the mass spectrometer due to space charge and magnetic field saturation. E. W. BECKER AND W. WALCHER. *Z. Phys.*, **131**, 395–407 (*No.* 3, 1952) *In German.*

These are calculated for a 60° mass spectrometer and show good agreement with experimentally determined values. J. HUGHES

537.534.72

5845. Magnetic analysers for nuclear disintegration studies. J. M. FREEMAN. *Atomics* [*Lond.*] **3**, 117–25, 131 (*May*, 1952).

A general account of the principles of the method, with details of some practical instruments of single and double focusing type. Solid angle and resolution are discussed, and there are diagrams and references. T. G. PICKAVANCE

537.534.72

5846. Optimum geometrical conditions for mass spectrometers. C. GEOFFRION. *Rev. Sci. Instrum.*, **23**, 224–8 (*May*, 1952).

The relations between slit dimensions, beam divergence, luminosity and resolving power of various single-focusing mass spectrometers are established. From these, the conditions for maximum luminosity for a given resolving power are derived. It is found that a third-order spectrometer operated under optimum conditions can be more luminous than one of conventional design. Data are given. A.

537.534.74

5847. Multiple scattering of protons in gases. E. H. GERBER. *Phys. Rev.*, **86**, 525–6 (*May* 15, 1952).

The tracks left in a cloud chamber by low-energy protons were observed in the absence of a magnetic field. Measurements of the curvature of the tracks due to multiple scattering verified quantitatively the results predicted by H. A. Bethe and W. T. Scott. For 1·08 MeV protons in air under a pressure of one atmosphere, the mean square curvature $\langle C^2\rangle_{Av}$ of the measured tracks was found to be $\langle C^2\rangle_{Av} = 0{\cdot}323\times10^{-3}\,\mathrm{cm}^{-2}$, for 1·05 MeV protons in argon $\langle C^2\rangle_{Av} = 0{\cdot}935\times10^{-3}\,\mathrm{cm}^{-2}$. For helium only qualitative results were obtained; they indicated smaller curvatures than for the other gases. A.

537.534.74 : 778.3

Methods of measuring multiple scattering in photographic emulsions. *See Abstr.* 6239

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 621.311.

5848. Power supply for a thermionic ion source. C. REUTERSWÄRD. *J. Sci. Instrum.*, **29**, 184–5 (*June* 1952).

The demands of a thermionic ion emitter with regard to heating power stability are stated, considering the Richardson formula. Characteristics and details of a regulated alternating current generator are given by means of which ion currents constant to some tenths % are obtained. The requirements of the electronic equipment in regard to the regulation of h.t. and cathode heating are discussed. A.

537.54

5849. A proportional counter for neutron flux measurements in the energy range 0·1 to 1 MeV. T. H. R. SKYRME, P. R. TUNNICLIFFE AND A. C. WARD. *Rev. Sci. Instrum.*, **23**, 204–8 (*May*, 1952).

A proportional counter, filled with hydrogen or methane, has been developed for the measurement of monoenergetic neutron fluxes in the energy range 0·1 to 1·0 MeV. The pulse distributions obtained from the recoil protons are in good agreement with the calculated distributions allowing for end and wall effects over this energy range for appropriate fillings. Flux measurements can be made with certainty to better than 5%. Calculations of wall and end effects have been repeated using the latest range energy relation for protons. A.

537.54

5850. Wavelength resolution of X-ray proportional counters. A. R. LANG. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 372–3 (*May*, 1952).

Unlike Arndt and Riley [Abstr. 4413 (1952)] the writer could separate Cu$K\alpha$ radiation from its 1st harmonic. Cr, Mn and Fe$K\alpha$ are almost completely separated from Cu$K\alpha$; there is good discrimination of Cu$K\alpha$ against Co$K\alpha$ and Fe$K\beta$, but not against Co$K\beta$. F. R. HOL

537.54

5851. A gap ionization chamber for measuring γ-rays. I. V. ESTULIN. *Zh. Eksper. Teor. Fiz.*, **21**, 1412–1 (*No.* 12, 1951) *In Russian.*

The construction of such a 400 cm³, ~1 cm wide chamber with walls of C, Al, Fe, Cu, Sn and Pb i

described. The relative equilibrium intensities of electrons produced in several materials by γ-rays were obtained. W. J. SWIATECKI

537.542

5852. An ionisation chamber for the measurement of substandard sources. F. WADE. *Atomics* [*Lond.*] **3**, 130–1 (*May*, 1952).

Describes the T.P.A. Mark IV ionization chamber filled with 1 atm. of argon. When used with Co^{60} the chamber saturates at 200–600 V for source strengths varying from 80 to 500 mc. 1 mc radium gave a saturated ionization current of $0{\cdot}66\times10^{-10}$ A. J. D. CRAGGS

537.542 : 548.736.1

5853. The texture of diamonds used for counting α, β or γ particles as found from divergent-beam X-ray photographs. H. J. GRENVILLE-WELLS. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 313–20 (*May*, 1952).

Since the radiation-counting efficiency of diamonds is a structure-sensitive property, X-ray experiments have been undertaken to see whether it is related to crystal texture. A technique for obtaining divergent beam photographs superimposed on Laue photographs has been developed, and results are given for 28 out of 38 colourless octahedral diamonds (edge 1–3 mm) whose u.v. transparency, β-particle counting efficiency and fluorescence are known. The relative strength of the anomalous extra X-ray reflections generally found for comparatively perfect diamonds has also been determined for these 38 specimens. Counting efficiency does not seem to be closely related to texture and, in particular, mosaicity is not a necessary condition. A.

537.542 : 621.387.464

5854. A crystal-photomultiplier gamma counter for hospital use. A. H. WARD AND P. G. JENSEN. *J. Sci. Instrum.*, **29**, 181–3 (*June*, 1952).

The counter has a high efficiency, about 20% at 1·2 MeV. It has been used for hospital measurements on patients with radioactive contamination, on biological samples and on experimental animals. A.

537.542 : 539.16.08

Determination of specific activities of C^{14} labelled organic compounds with a water-soluble liquid scintillator. *See Abstr.* 6000

537.542

5855. Particle counting by Čerenkov radiation. J. MARSHALL. *Phys. Rev.*, **86**, 685–93 (*June* 1, 1952).

Cherenkov radiation particle counters of a number of types are in satisfactory use for the counting of high-energy mesons, electrons and protons. The problems associated with Cherenkov counting and some of the uses are discussed together with the design and performance of several types of counters. The uses include high-energy electron counting with the exclusion of neutrons and protons, measurement of the velocity of mesons, and the detection of high-energy neutrons in the presence of lower-energy neutrons by the Cherenkov threshold counting of recoil protons. A.

537.542 : 539.166

5856. Design and use of a coincidence circuit of short resolving time. R. E. BELL, R. L. GRAHAM AND H. E. PETCH. *Canad. J. Phys.*, **30**, 35–52 (*Jan.*, 1952).

A coincidence circuit for use with anthracene or stilbene scintillation counters is described. Its resolving time lies in the 10^{-9} sec range, in agreement with theoretical estimates of the minimum possible resolving time with these scintillation counters. Examples are given of the use of the circuit in the measurement of short γ-ray half-lives and, in conjunction with β-ray spectrometers, in the determination of the details of radioactive disintegration schemes. New results contained in these examples concern γ-rays from $Hg^{198,199}$, Xe^{131} and $ThC(Bi^{212})$. A.

537.542 : 621.318.572

5857. A printing recorder for use in conjunction with scaling units. A. R. LANG. *J. Sci. Instrum.*, **29**, 176–8 (*June*, 1952).

The machine prints on a 6 in wide continuous paper roll the counts registered by the counter and neons of one or two scaling units, together with an angle, recorded as degrees and minutes. Closure of an external contact triggers a relay-controlled sequence of operations of printing and moving on the paper, counting by the scaling units being interrupted momentarily while printing takes place. A.

537.542 : 621.383.27

5858. Non-linear amplification in E.M.I. photomultipliers. J. F. RAFFLE AND E. J. ROBBINS. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 320–4 (*May*, 1952).

The output pulse heights obtained from E.M.I. photomultipliers are found not always to be proportional to the quantity of light incident on the photo-surface of the photomultiplier. The photomultiplier ceases to be a linear amplifier of the incident light pulses when the charge density in the multiplier becomes too great. The relation between pulse height and energy loss of α-particles in various fluorescent materials has been determined at low values of charge density. A.

537.543 : 537.212

5859. Ions and electrons moving in vacuum with a single initial velocity. F. WENZL. *Z. angew. Phys.*, **4**, 94–104 (*No.* 3, 1952) *In German.*

A detailed calculation of the potential distribution between two parallel plates, at a given potential difference, when there is a stream of electrons (perpendicular to the plates and with a single initial velocity) from the cathode, and a similar stream of positive ions, with a single initial velocity, from the anode. P. M. DAVIDSON

537.543 : 621.385.16.029.6

5860. Instabilities in the smooth-anode cylindrical magnetron. L. A. HARRIS. *J. Appl. Phys.*, **23**, 562–7 (*May*, 1952).

A magnetically focused space-charge cloud of the type found in the smooth-anode magnetron is examined to determine whether a perturbation of the equilibrium condition will grow. A field analysis is carried out in which radial admittances are matched at the edge of the cloud. The solutions for the characteristic frequencies are complex, indicating that the disturbance grows with time. These instabilities occur at multiples of the Larmor frequency.

The solutions indicate that electrons oscillate with increasing swings, a process which absorbs energy. Instability therefore gives rise to some anode current even when the tube is "cut off," though r.f. power is not made available by the process. A.

537.543 : 621.385.833

5861. The effect of velocity distribution in a modulated electron stream. D. A. WATKINS. *J. Appl. Phys.*, **23**, 568–73 (*May*, 1952).

A method of solving electron beam problems is described which takes into account the thermal velocity spread. The method is based on the Liouville theorem. Two such problems are solved by means of a power series. In the case of small-signal velocity modulation of a drifting stream, the velocity spread distorts the shape of the standing wave of current which is produced, in addition to lengthening the plasma wavelength and the electronic wavelength. For a drifting stream with full shot noise in each velocity class at the input, a standing wave of noise current is produced with deep minima. The size of the first minimum is found to increase as the square of frequency and with increasing velocity spread. That full uncorrelated shot noise can produce a standing wave of convection current is somewhat surprising. The present analysis demonstrates that space charge is the important factor in determining the behaviour of noise currents in electron streams even at high frequencies, and that velocity spread plays a less important role. A.

IONIZATION . THERMIONICS 537.56/.58

537.56

5862. Total collision cross-sections of negative atomic iodine ions in nitrogen and argon. F. L. MCCRACKIN. Letter in *Phys. Rev.*, **86**, 135–6 (*April* 1, 1952).

A radiofrequency mass spectrometer, with an oxide-coated cathode poisoned with iodine, was used to give 9 ± 3 and $14 \pm 3 \times 10^{-16}$ cm^2 for nitrogen and argon respectively. T. G. PICKAVANCE

537.561

5863. Excitation and ionization energies of halogenbenzenes. H. HARTMANN AND H. GRUNERT. *Z. phys. Chem.*, **199**, 259–65 (*Feb.*, 1952) *In German.*

An apparatus is described making use of electron impact technique. The disintegration of the gases at the hot electrode is avoided. For C_6H_6 the ionization potential is found to be 9·5 eV. J. JACOBS

537.564

5864. Collision dissociation of ions in a mass spectrometer. A. HENGLEIN. *Z. Naturforsch.*, **7a**, 165–71 (*Feb.*, 1952) *In German.*

A parabola spectrograph was used to study the dissociation of ions by collision with gas molecules. Many ions were produced which are normally only partially formed in a mass spectrograph, e.g. doubly charged ions of the form $C_xH_y^{++}$. J. HUGHES

537.56

5865. Some observations on the dissociation spectr of ions. A. HENGLEIN. Note in *Z. Naturforsch.*, 7 208–9 (*Feb.*, 1952) *In German.*

A discussion of the modes of decay of ions of th type C_3H_n, observed in previous work (precedin abstract). J. HUGH

537.564 : 537.568 : 537.58

5866. Ions produced in a room by ultra-violet lig from a quartz-mercury arc and by an open electri heater. H. NORINDER AND R. SIKSNA. *IV.* [*Stockholm*] **23**, 64–70 (*No.* 2, 1952).

Describes measurements using several ion counter which enabled the ions to be classified on a mobilit scale. Mobilities varied down to $\sim 2 \cdot 5$ 10^4 cm/sec/V/cm. Ion densities varied up t $\sim 30\,000$/cm^3, and were measured as a function c time, with the source switched on and off at know times. Mechanisms of ion-formation are discussed. J. D. CRAG

537.56

5867. Decomposition of negative ions in collision with atoms. V. M. DUKELSKIĬ AND E. YA. ZANDBER *Zh. Eksper. Teor. Fiz.*, **21**, 1270–83 (*No.* 11, 1951) *Russian.*

During the passage of the negative ions Na^-, K^- F^-, Cl^-, Br^- and I^- through a chamber filled wit helium at a pressure of about 10^{-3} mm Hg slo electrons were observed. On the example of the Na and I^- ion it is shown that these electrons are pro duced by the break-up of the negative ions in collisio with the helium atoms. The effective cross-sections of this process were determined for the energy rang 300 to 1300 eV of the ions. For the Na^- and I^- ion the corresponding cross-sections were also determine for argon. In the energy interval mentione $\sigma \simeq 10^{-16} - 10^{-15}$ cm^2. In all cases σ increases wit the energy of the ions. For the I^- ions in helium threshold is observed at the energy of 290 eV. N simple relation between σ and the bond energy c the residual electron could be found for the ion investigated. B. F. KRAU

537.58

5868. The thermionic constants of metals and semi conductors. I. Graphite. S. C. JAIN AND K. S KRISHNAN. *Proc. Roy. Soc. A*, **213**, 143–57 (*June* 2 1952).

The thermionic constants of graphite are deter mined by finding by Knudsen's effusion method th saturation vapour pressure of the electron gas in graphite chamber, at different known temperature and applying the well-known Clapeyron–Clausiu thermodynamic relation. The work function ϕ c graphite determined in this manner is $4 \cdot 62 \pm 0 \cdot 02$ eV and the effusion constant A, analogous to the emissio constant in Richardson's equation, is 60 ± 2 A cm^{-2} deg.$^{-2}$. The introduction of metals lik Pt or W into the graphite chamber does not affec the rate of effusion detectably, i.e. does not affec either ϕ or A determined therefrom, and these con stants are also quite insensitive to any contaminatio of the graphite surface by normal adsorption, even i conditions in which the emission of electrons from th surface is greatly suppressed. These observation

emphasize the advantages of this method of determining the thermionic constants of graphite over the usual methods. They further suggest that: the contact potential between graphite and the metal introduced into the chamber almost exactly compensates for the difference between their work functions; the effusion coefficients A of these metals are practically the same as for graphite, namely, 50 A cm^{-2} deg.$^{-2}$; surface contamination of the walls of the chamber behaves in the same way as the metals introduced in it; any observed differences in the emission coefficients of these metals should be attributed to differences in the reflection coefficients of their surfaces for electrons; and contamination of the surface affects its reflection coefficient very markedly. Measurements are also reported incidentally for the spectral emissivity of graphite for electromagnetic radiations in the neighbourhood of 6550 Å at different temperatures. A.

537.583

5869. Thermionic constants of graphite. K. S. Krishnan and S. C. Jain. Letter in *Nature* [*Lond.*] **169,** 702–3 (*April* 26, 1952).

The thermionic constants of graphite were measured by determining the saturation vapour pressure of the electron gas in equilibrium with the substance at known temperatures. This is done by measuring the rate of effusion through a small hole in a thin wall of a chamber scooped out of the substance. The values found were $\phi = 4{\cdot}62 \pm 0{\cdot}02$ eV. $A = 60 \pm 2$ A/cm^2/deg.^{2} A. H. W. BECK

537.583 : 548.73

5870. A study of oxide-coated cathode by X-ray diffraction method. E. Yamaka. Letter in *J. Appl. Phys.*, **23,** 498–9 (*April*, 1952).

See Abstr. 8808 (1951). The earlier note reports measurements of the rate of growth of (BaSr)O. BaO grows more quickly than the double oxide. (BaSrCa)O grows slowly up to 1100°c. The relation between crystal size of BaO and the thermionic emission was determined and a theoretical explanation is given. A. H. W. BECK

COSMIC RAYS 537.591

537.591.08

5871. A simple cosmic-ray-meter, plotting hourly values [automatically] corrected for pressure. K. G. Malmfors. *Ark. Fys.*, **4,** 411–13 (*Paper* 25, 1952).

537.591.1

5872. On the ionization in the stratosphere produced by various components of cosmic radiation. N. L. Grigorov, I. M. Evreinova and S. P. Sokolov. *Dokl. Akad. Nauk SSSR*, **81,** 379–82 (*No.* 3, 1951) *In Russian.*

Analysis of the counting rates, coincidences and pulse magnitudes from a 15 cm dia. Al pulse chamber within a concentric ring of G.M. counters at altitudes up to 24 km, leads to the conclusion that primary particles of energy $> 1{\cdot}5 \times 10^9$ eV expend approximately 40% of their energy on nuclear disintegrations. F. QUELON

537.591.1

5873. Examination of the mass-spectrum of cosmic ray particles at sea-level. A. I. Alikhanov and G. P. Eliseev. *Zh. Eksper. Teor. Fiz.*, **21,** 1009–22 (*No.* 9, 1951) *In Russian.*

A new mass-spectrometer is described briefly which allowed more accurate measurements to be made both of the masses and of the trajectories. Apart from mesons of 215 m_e other particles, 3–5 times less frequent, of mass 260–280 m_e were observed. J. JACOBS

537.591.1

5874. The neutron component of cosmic radiation. G. Pfotzer. *Naturwissenschaften*, **39,** 149–58 (*No.* 7, 1952) *In German.*

Reviews: history; slowing down and absorption in air; methods of measurement; production in solids and relation to other cosmic-ray phenomena; production in the atmosphere in relation to the β-activity of C in biological substances. W. J. SWIATECKI

537.591.1

5875. Production cross section and energy spectrum of the neutral mesons in cosmic rays. G. Salvini and Y. Kim. Letter in *Phys. Rev.*, **85,** 921–2 (*March* 1, 1952).

The mesons were created in sodium iodide crystals mounted inside a cloud chamber and were detected by IP21 photomultipliers. The energy distribution (up to ~ 1500 MeV) is similar to that of charged pions (Camerini *et al.* [Abstr. 6622 (1950)]), the abundance ratio $\pi^\circ/(\pi^+ + \pi^-)$ is $\sim 0{\cdot}4$ and the π° production cross-section increases from $0{\cdot}22 \pm 0{\cdot}06$ geometrical at 0·8–2 BeV to $0{\cdot}7 \pm 0{\cdot}15$ at > 2 BeV. W. J. SWIATECKI

537.591.1

5876. The primary cosmic radiation at high latitudes. M. A. Pomerantz and G. W. McClure. *Phys. Rev.*, **86,** 536–45 (*May* 15, 1952).

Various properties of the new group of low-energy primary cosmic-ray particles ($E < 1{\cdot}6$ BeV for protons) which enter the top of the atmosphere at geomagnetic latitudes north of 52° were investigated during the summer of 1950. Measurements at both 52°N (Swarthmore, Pennsylvania) and 69°N (Fort Churchill, Manitoba) were obtained with the same quadruple-coincidence counter trains used previously, oriented either horizontally or vertically, and with pulsed ionization chambers biased to detect bursts exceeding 1·0 Po-α. No diurnal or temporal variations in the cosmic-ray intensity were detected, and no change between 1949 and 1950 was indicated. Flights were conducted with counter trains containing various thicknesses of interposed Pb absorber. In contrast with the 46% increase in the vertical intensity between the two stations, no latitude effect was revealed either in the flux of cosmic rays travelling in the horizontal direction or in the frequency of bursts detected by the ionization chambers, at the highest altitudes attained (~ 9 mm of Hg). The data permit conclusions to be drawn regarding the horizontal component, the solar dipole-moment, the nature of the low-energy spectrum, as well as nuclear disintegrations and primary heavy nuclei. A.

537.591.1

5877. Composition and time variation of primary cosmic radiation. D. Lal, Y. Pal, M. F. Kaplon and B. Peters. Letter in *Phys. Rev.*, **86**, 569–70 (*May* 15, 1952).

Flux of heavy primary nuclei has been measured at geomagnetic latitude 3° using nuclear emulsions. Values obtained are in agreement with energy spectrum given previously [Abstr. 2807 (1952)]. The composition of the primary radiation is discussed and it is concluded that there is no marked change over the energy range 5×10^{9}–5×10^{11} eV/nucleon.

H. ELLIOT

537.591.1 : 539.155.2

5878. The absorption rate of cosmic-ray neutrons producing C^{14} in the atmosphere. R. Ladenburg. Letter in *Phys. Rev.*, **86**, 128 (*April* 1, 1952).

The absorption rate has been recalculated using recent values of the neutron absorption cross-sections and is found to be consistent with the observed abundance of C^{14}.

H. ELLIOT

537.591.1 : 539.155.2

5879. The production rate of cosmic-ray neutrons and C^{14}. H. J. Kouts and L. C. L. Yuan. Letter in *Phys. Rev.*, **86**, 128–9 (*April* 1, 1952).

Gives a revised estimate of the rate of production of C^{14} by cosmic-ray neutrons. Within the experimental uncertainty this agrees with the observed disintegration rate of C^{14}.

H. ELLIOT

537.591.15

5880. On a non-electromagnetic cascade process in cosmic-ray showers. M. I. Podgoretskiĭ. *Zh. Eksper. Teor. Fiz.*, **21**, 1097–108 (*No.* 10, 1951) *In Russian.*

The theory of detecting a cascade process by means of a system of coincidence-anticoincidence counters is given and applied to interpret the experiments of Podgoretskiĭ *et al.* [Abstr. 429 (1951)] and Veksler *et al.* (1947). It is concluded that at least in some electron-nucleon showers there appear two (or more) secondaries capable of generating further such showers.

W. J. SWIATECKI

537.591.15

5881. The effect of showers on the absolute measurement of the cosmic ray intensity. G. Bonnevay. *J. Phys. Radium*, **13**, 68–73 (*Feb.*, 1952) *In French.*

Describes an absolute measurement of the vertical cosmic-ray intensity using a counter telescope. Special attention is paid to the correction for showers. The value found for the intensity corrected to 76 cm Hg is $(1{\cdot}20 \pm 0{\cdot}04)10^{-2}$ particles/cm²/steradian.

H. ELLIOT

537.591.15

5882. Observation of Rossi showers with a Wilson chamber. J. Daudin and Tsai-chü. *C.R. Acad. Sci.* [*Paris*] **234**, 1277–8 (*March* 17, 1952) *In French.*

Four hundred shower photographs were taken at Pic du Midi (2860 m) using a chamber containing a 1·5 cm Pb plate and triggered by coincidences from 3 small counters placed in the chamber 12 cm below the plate. Less than half the coincidences are due to showers initiated by single electrons or photons, the remainder being complex events involving more than one primary.

H. ELLIOT

537.591.1

5883. The occurrence of heavy mesons in penetrating showers. R. B. Leighton and S. D. Wanlass. Letter in *Phys. Rev.*, **86**, 426 (*May* 1, 1952).

Discusses three events observed in cloud chamber photographs. Two of these probably represent the decay in flight of τ mesons and the third the decay of a κ meson. The masses are estimated to be $\sim 975\ m$ and $(1200 \pm 300)\ m_e$ respectively. It is claimed that an additional three tracks which have been observed may indicate the existence of a particle in the mass range $(400–650)\ m_e$.

H. ELLIOT

537.591.1

5884. The association of bursts and penetrating showers. D. E. Hudson. *Phys. Rev.*, **86**, 453–6 (*May* 15, 1952).

Local cosmic-ray bursts and penetrating showers have been studied together using an arrangement of ionization chambers and shielded counters. The experiment investigated (1) the occurrence of penetrating showers associated with large bursts, and (2) the occurrence of bursts associated with large penetrating showers. Evidence is presented to show that the bursts are mainly locally generated large electronic cascades. Nearly 60% of bursts larger than 25 BeV (about 250 electrons) contained observed penetrating component. The transition effect of penetrating and non-penetrating bursts was in qualitative agreement with a nuclear cascade process. Bursts of a few hundred electrons contained on the average about 1% of penetrating particles. Essentially no penetrating showers of multiplicity over 14 were unaccompanied by fairly large electronic cascades. The consistent association of cascade bursts with penetrating showers and vice versa is in qualitative agreement with present neutral meson concepts. The main experimental work was done at Echo Lake, Colorado (elev. 3260 m).

A.

537.591.2 : 531.761 : 621.317.755

5885. A high speed chronograph and its application to the time of flight of cosmic rays. V. C. Officer. *Aust. J. Sci. Res. A*, **4**, 526–43 (*Dec.*, 1951).

A high-speed chronograph using a 20-turn spiral time base of 1 μsec duration per turn is described together with its video amplifiers, delay lines, radial deflection circuits, and recording equipment. The time of flight of cosmic-ray mesons over a range of 5·45 m has been detected using ordinary Geiger counters, and found to agree with the velocity of light within the accuracy of the experiment. A time lag of 2×10^{-8} sec between the firing of a tray of counters shielded with 10 cm of lead and the firing of a similar unshielded tray by extensive air showers has been accounted for, and the results shown to be consistent with the theoretical expectation that most of the shower particles arrive at the trays within a time $< 10^{-9}$ sec.

A.

537.591.5

5886. On the galactic variation of cosmic rays. A. Daudin and J. Daudin. *C.R. Acad. Sci.* [*Paris*] **234**, 1551–3 (*April* 7, 1952) *In French.*

Air showers observed at the Pic du Midi with

ounter trays separated by 80 m show an apparent idereal variation of amplitude $0{\cdot}39 \pm 0{\cdot}13\%$ with a ime of maximum at 22 hr. The variation in shower ate is compared with a similar variation for radio oise. H. ELLIOT

537.591.5

5887. The high latitude north-south asymmetry of osmic rays. D. W. P. BURBURY. Letter in *Phys. Rev.*, **86**, 577–8 (*May* 15, 1952).

The north-south asymmetry has been measured nder 12 cm Pb at geomagnetic latitude 51·7° S for zenith angle 30°. Value obtained is $0{\cdot}0056 \pm 0{\cdot}0013$, the greater intensity being from the north. his asymmetry is attributed to different path lengths hrough the atmosphere for the secondary particles lue to deflection in the earth's magnetic field. H. ELLIOT

537.591.8

5888. An investigation, using scintillation counters, of "double stars" due to cosmic rays. J. B. HARDING. Letter in *Nature* [*Lond.*] **169**, 747–8 (*May* 3, 1952).

The coincidence rate for stars produced in two adjacent potassium iodide scintillation counters has been measured and it is concluded that the contribution due to double stars, if any, is considerably less than would be expected from earlier emulsion results (see also Abstr. 5186 (1952)]. H. ELLIOT

537.591.8

5889. The production of high-energy secondaries by cosmic rays underground. W. E. HAZEN. *Phys. Rev.*, **86**, 764–6 (*June* 1, 1952).

The traversal of a total of 100 m of Pb by penetrating particles has been studied at an underground depth of $3{\cdot}4\times10^5$ g cm^{-2} with a cloud chamber containing 2·54 cm Pb plates. The observed probability for an energy transfer greater than 10^9 eV to the soft component is $3{\cdot}0(\pm0{\cdot}7)\times10^{-4}$ per g cm^{-2} of Pb. Knock-on, bremsstrahlung, and pair-production processes are calculated to give a probability of $2{\cdot}1\times10^{-4}$ per g cm^{-2} of Pb. Therefore, the above electromagnetic phenomena account for nearly all of the high-energy soft secondaries produced by μ-mesons of energy $\sim 10^{11}$ eV. A.

MAGNETISM 538

538.082.1 : 621.317.42

5890. On a new apparatus for the measurement of the intensity of a magnetic field. R. BIREBENT. *C.R. Acad. Sci.* [*Paris*] **234**, 1135–6 (*March* 10, 1952) *In French.*

The force exerted on a rectangular conductor carrying a.c. and placed perpendicular to the magnetic field is transmitted to a piezoelectric crystal. The alternating potential obtained from the crystal is amplified for easy measurement and is $\propto$ magnetic field strength. Measurements are possible over an extended range of field strengths ($\sim$ 20–20 000 Oe). H. P. MYERS

538.11

5891. Theory of antiferromagnetic resonance in a crystal of rhombic symmetry at the absolute zero. J. UBBINK. Letter in *Phys. Rev.*, **86**, 567–8 (*May* 15, 1952).

An application of existing theories to an interpretation of the findings of Poulis *et al.* [Abstr. 6346 (1951)] that the resonance phenomena in $CuCl_2 . 2H_2O$ are only slightly temperature-dependent below about 3°K. E. P. WOHLFARTH

538.11

5892. An approximate quantum theory of the antiferromagnetic ground state. P. W. ANDERSON. *Phys. Rev.*, **86**, 694–701 (*June* 1, 1952).

A careful treatment of the zero-point energy of the spin-waves in the Kramers–Heller semiclassical theory of ferromagnetics leads to surprisingly exact results for the properties of the ground state, as shown by Klein and Smith. An analogous treatment of the antiferromagnetic ground state, whose properties were unknown, is here carried out and justified. The results are expected to be valid to order $1/S$ or better, where S is the spin quantum number of the separate atoms. The energy of the ground state is computed and found to lie within limits found elsewhere on rigorous grounds. For the linear chain, there is no long-range order in the ground state; for the simple cubic and plane square lattices, a finite long-range order in the ground state is found. The fact that this order can be observed experimentally, somewhat puzzling since one knows the ground state to be a singlet, is explained. A.

538.11 : 537.36 : 621.3.013

5893. Electro-kinetical explanation of the laws of magnetostatics. B. A. SADIKOV. *Elektrichestvo*, *No.* 1, 34–41 (1952) *In Russian.*

A systematic and more complete treatment of the main problems of magnetostatics based on the work of V. K. Arkadiev in his book *Electromagnetic Processes in Metals* (Moscow, 1935). The flux density set up by a circular current is first considered and the magnetic moment of such a current is introduced, then proceeding to infinite and finite solenoids to replace magnetic poles and bar magnets. B. F. KRAUS (R)

538.114

5894. Calculation of the magnetic skin-effect in Permalloy sheet and determination of its characteristic parameters. A. A. SHVARTS. *Zh. Tekh. Fiz.*, **21**, 1293–310 (*No.* 11, 1951) *In Russian.*

The investigation of the behaviour of ferromagnetic cores in weak fields is usually based on an empirical relation between flux density and field strength, and for a sinusoidal field variation this formula permits of deriving approximations for effective permeability and loss resistance for a toroidal core of sheet material. These formulae may be generalized on the domain theory, i.e. by introducing the reversible and irreversible displacements of the domain boundaries and the friction forces (due to micro-eddy currents) slowing down these displacements and leading to a decrease of μ and increase of the loss factor with increasing field frequency. But the diffusion of foreign atoms into the crystal lattice has also to be considered, this delaying the boundary displacements even in the absence of friction forces (delay with respect to the exciting field). The equation of motion

of the domain boundaries will thus at least involve the quasi-elastic lattice forces and the "friction" forces opposing the immigration of the foreign atoms (ions) into the lattice. These assumptions lead to a generalized and physically sound *B–H* relation. The losses in the ferromagnetic core, without considering micro-eddy currents, but inclusive of the case of an inhomogeneous ferromagnetic, may then be computed, and the micro-currents introduced later by a more "technical" method based on an equivalent circuit attributing resistance and reactance to the ferromagnetic losses. The combination of the author's theory with a frequency relation of the complex permeability for strong magnetic skin-effect given by Polivanov [Abstr. 1492 (1949)] leads to a new method of loss separation, the constants of which may be experimentally determined. Comprehensive experimental data are evaluated by the new method, which is much simpler to handle than previous methods and provides a much clearer insight into the properties of ferromagnetics in weak fields. B. F. KRAUS

538.12 : 538.3 : 532.51

On the behaviour of an electrically conductive liquid in a magnetic field. *See Abstr.* 5579

538.214 : 538.69 : 548.0

5895. Some peculiarities in the magnetic properties of zinc single crystals at low temperatures. B. I. VERKIN. *Dokl. Akad. Nauk SSSR*, **81**, 529–32 (*No.* 4, 1951) *In Russian.*

Some aspects of the de Haas–van Alphen effect in zinc have been studied at 4·2°K and 1·88°K up to 15 000 gauss. Attention is drawn to the maximum in the envelope of the oscillations [predicted by the theory and previously found by Mackinnon, Abstr. 2012 (1949)] and estimates of the electronic parameters based partly on the position of the maximum are made. The usual inconsistencies of details between the Landau formula and the experimental data are found [see also Dingle and Shoenberg, Abstr. 1176 (1951)]. D. SHOENBERG

538.22

5896. The influence of the crystalline field on the magnetic properties of anhydrous neodymium cobalt cyanide and hydrated beryllium and neodymium nickel cyanides. N. PERAKIS AND T. KARANTASSIS. *C.R. Acad. Sci.* [*Paris*] **234**, 1759–61 (*April* 28, 1952) *In French.*

Susceptibility measurements on $NdCo(CN)_6$, $BeNi(CN)_4 . 2H_2O$ and $Nd_2Ni_3(CN)_{12} . 7H_2O$ between 80° and 290°K are reported. Differences between observed and calculated ionic moments are ascribed to the effects of the crystalline field in partially destroying spin-orbit and Russell–Saunders coupling. E. P. WOHLFARTH

538.22 : 536.48

5897. Magnetic permeability of solid oxygen at low temperatures. A. S. BOROVIK-ROMANOV. *Zh. Eksper. Teor. Fiz.*, **21**, 1303–8 (*No.* 11, 1951) *In Russian.*

The absolute values of the magnetic permeability of liquid oxygen at 77°K and of solid oxygen at 20°K were measured. The temperature relation of the permeability of solid oxygen was determined between 20 and 14°K, and between 4·2 and 1·5°K. The value of the permeability falls by 9% according to a quadrati law between 20 and 14°K, at 4·2° is the same as at 14 and shows a weak linear rise from 4·2 to 1·5 (by ~5%). The method of investigation was modified ballistic method with an open galvo circui by which the sensitivity was increased by almost full order of magnitude. B. F. KRAU

538.22

5898. Magnetic spectra of NiZn ferrites at radi frequencies. L. A. FOMENKO. *Zh. Eksper. Teo Fiz.*, **21**, 1201–8 (*No.* 11, 1951) *In Russian.*

Problems of the frequency relation of the elast and viscous permeability of the ferrites at radio frequencies are considered, it being found that th specimens of NiZn ferrites investigated possess continuous magnetic spectrum with distinct dispersio bands of the elastic permeability and absorptio bands of the viscous permeability in the frequenc range 0·75–360 Mc/s. The frequency limits of th uniform distribution of the characteristic frequenci of the magnetic relaxation of the substance depen mainly on the values of the initial permeabilities of th ferrites and shift with decreasing softness to eve higher frequencies. The character of the frequenc relation may be approximated by the equations of th relaxation movement of Arkadiev's theory of th continuous spectra of magnetic viscosity. B. F. KRAU

538.22

5899. Nuclear magnetic resonance in an anti ferromagnetic single crystal. I. N. J. POULIS AN G. E. G. HARDEMAN. *Physica*, **18**, 201–20 (*Apri* 1952).

Nuclear magnetic resonance absorption of proton in a single crystal of $CuCl_2 . 2H_2O$ was studied. A temperatures of liquid H the resonance diagrams ar similar to those in single-crystals of the paramagneti salt $CuSO_4 . 5H_2O$. In the liquid He region, however the resonance diagrams are always symmetrica about the proton line in water. This symmetry ar also the temperature dependence of the resonanc lines indicate that $CuCl_2 . 2H_2O$ is anti-ferromagneti below about $T = 4·3$°K. A threshold value of th magnetic field as predicted by Néel has been found Measurements have been carried out both in a fiel below and in a field above this threshold valu From the measurements in weak fields the position c the protons in the crystal can be calculated.

538.221 : 621.318.1

5900. Ferroxdure, a class of new permanent magne materials. J. J. WENT, G. W. RATHENAU, E. W GORTER AND G. W. VAN OOSTERHOUT. *Philips Tech Rev.*, **13**, 194–208 (*Jan.*, 1952).

The material manufactured at present under th name of Ferroxdure is an oxidic ceramic material c the approximate composition $BaFe_{12}O_{19}$. It is magnetically hard material containing no Co or N and thus offers great economic advantages. It characterized by possessing an extremely high valu of the coercive force and rather low remanence an saturation magnetization. The extremely high valu of the coercive force is due to a large crystal anisc tropy. The combination of the two properties, larg coercive force and low saturation magnetizatio means that the material has a large resistance t

demagnetization and thus is very well suited for applications where a large resistance to demagnetization is of importance. In the second place these properties open new ways for the design of permanent magnets. The $(BH)_{max}$ value of Ferroxdure is rather low. Its specific electric resistivity is high so that it is very well suited for h.f. applications. The low value of the saturation magnetization and of the remanent magnetization can be understood to be due to the fact that the mechanism which determines the magnetic behaviour of Ferroxdure is non-compensated antiferromagnetism. A.

538.221 : 621.318.23

5901. Permanent magnets for spectrographs and nuclear physical research. D. HADFIELD AND D. L. MAWSON. *Brit. J. Appl. Phys.*, **3**, 199–202 (*June*, 1952).

Composite permanent magnets, embodying the latest anisotropic alloys, are being used increasingly in equipment for research in many branches of applied physics. Among the advantages are freedom from power supplies, and also constancy of field, when compared with the electromagnet. Flexibility is achieved in the electro-permanent magnet by either reinforcing the permanent magnet field or artificially ageing to a reduced value of field strength. Particular applications are for cosmic-ray traps, nuclear magnetic resonance apparatus, mass spectrometers, and β-ray spectrographs, the design of a magnet for the latter purpose being discussed in detail. A.

538.222

5902. Paramagnetic resonance absorption of microwaves. R. T. WEIDNER AND C. A. WHITMER. Letter in *J. Chem. Phys.*, **20**, 749 (*April*, 1952).

The shape of the resonance curves obtained for powdered paramagnetic salts may be affected by the exptl. conditions under which measurements were conducted by Lancaster and Gordy [Abstr. 8846 (1951)]. Thus, no conclusion regarding exchange interactions may justifiably be made from shape analyses of these curves. G. I. W. LLEWELYN

538.222

5903. Magnetic susceptibilities of europium sesquioxide and of uranium dioxide at low temperatures. B. M. W. TRAPNELL AND P. W. SELWOOD. Letter in *Nature* [*Lond.*] **169**, 840–1 (*May* 17, 1952).

Susceptibility measurements on Eu_2O_3 and UO_2 between 20° and 300°K are reported. After careful purification the susceptibility of Eu_2O_3 agrees moderately well with Van Vleck's formula with a screening constant $\sigma = 34$. Measurements on UO_2 do not indicate antiferromagnetism even at 20°K, the susceptibility obeying the Curie–Weiss law over the whole range. E. P. WOHLFARTH

538.222

5904. Nuclear magnetic resonance absorption in anthracene. F. A. RUSHWORTH. Letter in *J. Chem. Phys.*, **20**, 920–1 (*May*, 1952).

The change in line width by a factor of five observed by Andrew [*J. Chem. Phys.*, **18**, 607 (1950)] on varying the temperature between 160 and 200°K has been found to be due to an impurity (ethylene glycol) which itself undergoes a line-width transition in the solid state. L. PINCHERLE

538.222 : 541.67

5905. The method of paramagnetic resonance absorption in the magnetochemistry of organic compounds. B. M. KOZYREV. *Dokl. Akad. Nauk SSSR*, **81**, 427–30 (*No.* 3, 1951) *In Russian.*

Paramagnetic resonance at $2{\cdot}17 \times 10^8$ c/s and fields 0–250 Oersteds are used to obtain relative values of χ''. Three types of behaviour are observed: (1) No resonance, with benzene and furfural. (2) A single resonance peak at 160 Oersteds with $g \simeq 1$, almost independent of temperature, increasing by 15–30% on cooling from 300 to 90°K, with anthracene and alloöcimene. (3) Two peaks, one $g \simeq 1$ and clearly of type (2), and a second, $g \simeq 2$, typical of a free radical; the second peak almost vanishes at 90°K by virtue of diminished radical concentration; found with 1,9-bis-(2-furyl)-5-oxy-1,3,6,8,-nonatetraene and 1,9-diphenyl-5-oxy-1,3,6,8-nonatetraene. Type (2) resonance is puzzling—even paramagnetic dirt would hardly have $g \simeq 1$. D. H. WHIFFEN

538.224

5906. The diamagnetism of ions. W. R. MYERS. *Rev. Mod. Phys.*, **24**, 15–27 (*Jan.*, 1952).

A review covering the results of measurements on compounds containing simple ions, alkali, alkaline earth and halogen. Several methods of deriving ionic susceptibilities from the measurements are described, including the use of halogen acid measurements, the theoretical analysis of measured alkali halide susceptibilities and the use of homopolar susceptibility values. Tests of additivity rules are described and a discussion is given of susceptibility changes accompanying changes of state. The present status of theory and of experiment is considered.

E. P. WOHLFARTH

538.23

5907. On a magnetic hysteresis loop approximating in form to a right angle. M. V. DEKHTYAR AND L. M. DEKHTYAR. *Dokl. Akad. Nauk SSSR*, **81**, 533–6 (*No.* 4, 1951) *In Russian.*

Four wires of Permalloy (a Fe–Ni alloy) of dia. 0·5 mm were given the four following treatments respectively, after which the hysteresis curves were taken using an astatic magnetometer: (1) the wire was not given any preliminary treatment; (2) a stress of 57 kg/mm² was applied to the wire at room temp., followed by heating to 600 and maintaining this temp. for 15 min, the stress being then removed and the sample cooled to room temp.; (3) the wire was given a similar treatment to (2) but the stress was maintained during cooling; (4) the wire was given the same heat treatment but no stress was applied. Only for wire (2) was a hysteresis curve obtained which was right-angled. This tends to confirm the hypothesis advanced in Abstr. 498 (1951). Additional experiments showed that the steepness of the demagnetization part of the curve, for wire (2), increased with increasing rate of cooling. The Curie point for the wire was *c.* 400°. When a wire was given a similar heat treatment under stress to wire (2), but was cooled in a magnetic field of $H = 10$ Oe with a velocity of 3°/min, the curve lost its right-angled form. W. HUGHES

538.23

5908. Temperature-magnetic hysteresis in highly coercive alloys. Ya. S. Shur, N. A. Baranova and V. A. Zaikova. *Dokl. Akad. Nauk SSSR*, **81**, 557–69 (*No.* 4, 1951) *In Russian.*

Cylindrical rods (length 48 mm, dia. 2·7 mm) of Alniko (an alloy composed of 51% Fe, 24% Co, 14% Ni, 8% Al and 3% Cu) were treated as follows: (*a*) heating to 1300°c followed by cooling in either a longitudinal or transverse magnetic field; (*b*) annealing at 600°c for several hours. After such treatment samples cooled in longitudinal and transverse fields had coercive strengths of 550 and 250 oersteds respectively. Measurements of the temp.-magnetic hysteresis were made over a temp. range of — 195° to 550°c in a constant, magnetic field from 3 to 360 oersteds. Results given graphically showed that for samples treated in the longitudinal magnetic field, even at field strengths as low as 3 oersteds, there was a considerable temp.-magnetic hysteresis, which disappeared when the field strength reached 360 oersteds. For samples treated in a transverse magnetic field, the effect was not manifest till 12 oersteds and disappeared at 120 oersteds; in addition the absolute value of the hysteresis was considerably smaller than for the longitudinal magnetic fields. W. HUGHES

538.24

5909. Dependence of the coercive force on the particle size of powders of soft magnetic materials. Ya S. Shur, T. D. Zotov and I. A. Chebotarev. *Dokl. Akad. Nauk SSSR*, **81**, 387–9 (*No.* 3, 1951) *In Russian.*

538.24 : 536.48

5910. The spontaneous magnetization of magnesium ferrite and magnesium ferrite-aluminate powders at low temperatures. G. O. Jones and F. F. Roberts. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 390–1 (*May*, 1952).

Reports saturation measurements down to about 25°K on 6 compounds of spinel structure ranging from $MgFe_2O_4$ to $MgAlFeO_4$. In each case a monotonic increase appears to occur with decreasing temperature. It is concluded that the Al^{3+} ions go into octahedral lattice sites, causing a progressive reversion of the Mg^{2+} ions into tetrahedral sites, with about 20% greater occupation of octahedral than of tetrahedral sites by Fe^{3+} ions in each case.

F. F. ROBERTS

538.245

5911. Magnetic powder patterns. H. G. Gerlach. *Appl. Sci. Res. B*, **2**, 245–8 (*No.* 4, 1952).

Describes experiments on rolled Fe–Si strips annealed in H_2 and mechanically polished, surface strains being removed by etching. The patterns consist of groups of parallel lines differing in direction from one crystal grain to the next. In some cases a single grain contains two groups of perpendicular lines, the surfaces here being (100) and the lines being then capable of movement in a magnetic field parallel to the surface. E. P. WOHLFARTH

538.245 : 537.228.4

5912. Magnetic domains on silicon iron by the longitudinal Kerr effect. C. A. Fowler, Jr, and E. M. Fryer. Letter in *Phys. Rev.*, **86**, 426 (*May* 1, 1952).

Describes experiments to observe the domain structure on the (100) surface of an Fe–Si crystal by oblique reflection using the longitudinal Kerr magneto-optic effect. The plane of polarization of the reflected light suffers rotation, the sign of which depends on the direction of magnetization. The results are stated to be comparable with powder pattern results. E. P. WOHLFARTH

538.27

5913. The de Haas–van Alphen effect. D. Shoenberg. *Philos. Trans A*, **245**, 1–57 (*No.* 891, 1952).

The magnetic anisotropy of single crystals of various metals has been studied experimentally, particularly at liquid-He temperatures, and an oscillatory variation with field (de Haas–van Alphen effect) has been discovered in Ga, Sn, graphite, Sb, Al, Cd, In, Hg and Tl. After a brief statement of Landau's theory of the effect and some recent modifications by Dingle, the experimental technique is described and the results for the individual metals are presented. The effect has been studied most thoroughly for Ga, Sn, graphite and Sb, and it has been possible to explain the results in considerable detail on the basis of the theory, though some features such as the modulations of the oscillations cannot be fully explained. The effect can be explained if it is assumed that only a very small number of free electrons (ranging from 10^{-6} to 10^{-3} per atom) are effective, whose effective masses are small (usually $\sim 0{\cdot}1\ m_e$), and depend on the direction of the applied magnetic field. These "effective" electrons are presumably those which overflow at certain places in wave-number space from one Brillouin zone into another, or the "holes" left behind in nearly full zones, and their small effective masses are associated with large curvature of the Fermi surface in these regions. Although the oscillatory variation of anisotropy was the main object of the investigation, some new data on the steady part of the anisotropy were also obtained, and where a detailed comparison with theory was possible it was found that the free electrons effective in producing the oscillations could account only partly for the observed steady anisotropy. To explain both the temperature and field variation of the amplitude of the oscillations consistently it is necessary to add to Landau's formula an exponential "damping factor" involving a parameter x which has the dimensions of temperature and is usually of order 1°K. The effect of this "damping" is equivalent to that of raising the temperature by x°K. Dingle has shown that just such a factor is to be expected if broadening of the energy levels due either to collisions or other causes is taken into account. Experiments on the de Haas–van Alphen effect in a series of alloys of Sn with Hg and In support Dingle's interpretation in showing that the parameter x varies approximately linearly with the reciprocal of the collision time (i.e. with the residual resistance), and the slope of the linear relation gives a reasonable value of the collision time. It is clear, however, that collision broadening alone cannot account for the experimental values of x for pure metals, and other causes of level broaden-

ing, such as the effect of the electric field of the crystal lattice, must be invoked. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

5914. An electrical model for the understanding of the so-called Lorentz force. H. HINTEREGGER. *Acta Phys. Austriaca*, **5**, 398–403 (*No.* 3, 1952) *In German.*

Two parallel charged plates moving with equal and opposite velocities relative to a frame S generate a magnetic field. In a frame S' moving relative to S there will also be an electric field. The discussion is in terms of Flamm's field line mechanics [Abstr. 2885 (1948), 846 (1949)]. R. A. NEWING

538.3

5915. The physics of the electromagnetic universe. B. JOUVET. *C.R. Acad. Sci.* [*Paris*] **234**, 1532–4 (*April* 7, 1952) *In French.*

Continuing an earlier abstract investigation [Abstr. 4476 (1952)] it is suggested that electromagnetic quantities might be defined in terms of potential differences, and the introduction of a 4-dimensional metric potential-space is discussed. R. A. NEWING

538.3 : 532.5

5916. Studies in magneto-hydrodynamics. S. LUNDQUIST. *Ark. Fys.*, **5**, 297–347 (*Paper* 15, 1952).

A general survey is made of recent theoretical developments, and the emphasis is on the physical principles involved, a detailed discussion being given to illustrative examples. The topics considered include the influence on a magnetic field of steady liquid flow, waves in compressible and incompressible fluids, and the oscillations of a finite mass of liquid. Magneto-hydrodynamic turbulence is discussed in terms of symmetric field-vectors. In a final section, various laboratory investigations are considered R. A. NEWING

538.31 : 621.365.54

5917. Electromagnetic levitation of solid and molten metals. E. C. OKRESS, D. M. WROUGHTON, G. COMENETZ, P. H. BRACE AND J. C. R. KELLY. *J. Appl. Phys.*, **23**, 545–52 (*May*, 1952). Also in *J. Electrochem. Soc.*, **99**, 205–11 (*May*, 1952).

The subject is an unconventional method of heating and melting metals without a crucible, by suspension in space with an electromagnetic field. Operating conditions for certain cases are given. The results obtained by means of the new technique encourage the thought of melting, purifying, alloying and agitating of inert and reactive metals without resort to crucibles, and thereby avoiding the contamination of reactive metals by crucible materials. Preliminary results with various forms and masses of metal are described. The atmosphere in which levitation occurs is considered. A.

538.54 : 621.3.017.31

5918. Eddy-currents in solid cylindrical cores having non-uniform permeability. H. ASPDEN. *J. Appl. Phys.*, **23**, 523–8 (*May*, 1952).

A method of estimating magnetization losses due to eddy-currents in solid cylindrical cores of ferromagnetic material is given. The conception of complex permeability is introduced to show the effects which hysteresis has upon the degree of flux penetration. A formula is given for the effective permeability which should be used in the classical treatment in which non-linearities have been ignored. An arbitrary case, in which the permeability changes across the core section, is considered, and the solution is extended to a core which is homogeneous, but whose permeability changes with the degree of magnetization. In this way errors due to a non-linear B–H curve are reduced and the complex permeability notation is shown to lead to a more reasonable Steinmetz relationship. The eddy-current anomaly is mentioned and it is noted that the theory developed is suited to a consideration of the anomaly as explained in terms of time-lag effects. A.

538.55 : 621.3.013

5919. Current-carrying wire loops in a simple inhomogeneous region. J. R. WAIT. Letter in *J. Appl. Phys.*, **23**, 497–8 (*April*, 1952).

Formulae are obtained for the field of a small harmonically varying electric current circuit in the plane of separation of two uniform isotropic media, and for the steady-state mutual impedance of two small circuits in this plane. A. T. PRICE

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561

5920. High-frequency oscillations of an electron plasma. A. I. AKHIEZER AND YA. B. FAĬNBERG. *Zh. Eksper. Teor. Fiz.*, **21**, 1262–9 (*No.* 11, 1951) *In Russian.*

The interaction of a beam of charged particles with an electron plasma is considered. It is shown that the condition of the beam, characterized by constant and uniform velocity and density, becomes unsteady. If such a beam penetrates into the plasma, the density and velocity fluctuations in it are propagated in the form of waves of increasing amplitude. The longitudinal electric field set up in connection with this has also the character of a wave with increasing amplitude. The condition of the plasma is determined by a distribution function which at higher frequencies, when the collisions of pairs may be neglected, satisfies Vlasov's kinetic equation, $\partial F/\partial t + \bar{u}\,\partial F/\partial \bar{r} + e/m\,E\,\partial F/\partial \bar{u} = 0$, where $\bar{u}$ is the electron velocity in the plasma and E the self-consistent field acting on the plasma. It is also shown that waves of charge density of increasing amplitude may be set up when a beam of charged particles moves in a dielectric. In this case the instability of the beam and production of the waves in the frequency range where the dielectric constant is real takes place when $v_0 > s$, where $s = c/\sqrt{e}$ is the phase velocity of the wave propagation in the dielectric. This condition agrees with the condition of the Cherenkov radiation of the individual charged particles. In the adiaphanous (non-transparent)

range the instability occurs at all values of the velocity of the unexcited beam. B. F. KRAUS

538.561

5921. Some problems of the theory of the inhomogeneous non-isothermal plasma. I. YU. L. KLIMONTOVICH. *Zh. Eksper. Teor. Fiz.*, **21**, 1284–91 (*No.* 11, 1951) *In Russian.*

An equation is considered by which the Coulomb interaction of charged particles and their collision interaction with the gas atoms is described. The distribution function of the velocities is calculated for the case in which the effective cross-sections for elastic scatter of the electrons is inversely proportional to their velocity. The equation is obtained by an extension of Vlasov's equation for a self-consistent field by terms considering the external field and the distribution functions, and supplemented by a potential representation of the external field in the form of an integral equation with a kernel involving the distribution functions. A solution of the latter equation takes the form of an expansion in Legendrians. Substitution into the original equation yields Davydov's equation [*Zh. Eksper. Teor. Fiz.*, **7**, 1069 (1937)]. But, whereas Davydov's assumption of a cross-section independent of velocity leads to a fairly complicated distribution law, the inverse proportionality relation yields a Maxwell distribution. This applies also to a further extension of the problem, viz. the assumption of a magnetic field at right angles to the electric field (i.e. again Maxwellian distribution). In the absence of an electric field, the electron temperature remains constant (isothermal plasma), as could be expected. B. F. KRAUS

538.561

5922. Some problems of the theory of the non-isothermal plasma. II. Theory of the periodicity in space of the electron plasma. YU. L. KLIMONTOVICH. *Zh. Eksper. Teor. Fiz.*, **21**, 1292–302 (*No.* 11, 1951) *In Russian.*

The periodicity in space of the electron plasma is investigated on the system of equations: $\partial\phi_1/\partial t + \bar{V}\,\mathrm{grad}_r\phi_1 + e/m\,E_1\,\mathrm{grad}_{\bar{v}} f_0 + 1/\tau\,\phi_1 = 0$, $\mathrm{div}\,E_1 = 4\pi e\int\phi_1 dv$. According to Vlasov, space periodicity must occur when the directed electron velocity $>$ the mean thermal velocity of the electrons in the plasma; but hydrodynamical considerations (which yield the same result) may be applied only when the directed velocity $<$ thermal velocity, i.e. far from the transition range from uniform to space-periodical distribution. This "critical range" where the velocity distribution mentioned actually exists, must be determined by the kinetic equation. The author shows that the range is determined by the parameters pressure and current, establishes the existence criterion of space-periodicity in the plasma and the stability conditions of the zone, and further gives the relation between the space period and the plasma parameters. B. F. KRAUS

538.561 : 535.343.4 : 621.316.726 : 621.396.615.14

5923. The application of molecular resonance to microwave frequency stabilization. H. R. L. LAMONT AND E. M. HICKIN. *Brit. J. Appl. Phys.*, **3**, 182–8 (*June*, 1952).

A method is described of stabilizing the frequency of an oscillator by means of the molecular absorptions which occur in the microwave spectrum of some gases. Circuit details are given of an apparatus used with ammonia at wavelengths near 1·25 cm, and factors affecting performance are discussed theoretically. An N.P.L. test gave a measured stability figure of $\pm\epsilon$ parts in 10^7. Possibilities for other wavelengths are considered. A

538.561 : 537.52

5924. Wave theory of plasmas. D. GABOR. *Proc. Roy. Soc. A*, **213**, 73–86 (*June* 5, 1952).

The fluctuating electric microfield in a plasma in thermal equilibrium can be divided into two components. One has the character of rare sharp peaks due to the occasional close approach of single ions or electrons to the observation point, while the other, the background, results from the simultaneous action of a large number of more distant charges. This long-range component may be imagined as arising from the random superposition of intercrossing longitudinal plasma waves, with all wavelengths down to a small multiple of the Debye length. Their spectral energy distribution is obtained by counting the modes of oscillation by Jeans's method, combining this with the dispersion law given by Bohm and Gross, and giving each mode an energy kT. The cut-off near the Debye length is estimated by various considerations which lead to the conclusion that the spectrum extends approximately over one octave above the critical or "plasma frequency." The argument is supported by showing that there is a thermodynamical upper limit to the energy of the plasma waves. The scattering of electrons in a plasma by long-range effects is calculated from their momentum and energy exchange with the random plasma waves. It is found to be much smaller than the scattering due to close encounters, which proves conclusively that the phenomena first observed in low-pressure arc discharges by Langmuir, and which appear to suggest a very strong electron-electron interaction, cannot be accounted for by the dynamics of equilibrium or steady-state plasmas. This suggests very forcibly that these arc plasmas are the seat of strong, partially organized, self-excited oscillations, to which the considerations of the present paper do not apply. A

538.565 : 621.317.375.3.088

5925. The effect of stray reactances in a quarter-wave Lecher circuit for the measurement of permittivity. I. V. ZHILENKOV AND A. N. EFREMOV. *Zh. Eksper. Teor. Fiz.*, **21**, 839–44 (*No.* 7, 1951) *In Russian.*

The method employing a tuned Lecher circuit ($\lambda = 1$–10 m), is studied in relation to considerable errors, shown theoretically and experimentally to arise from the conductor supports, leads to the capacitance being measured, etc. The fixing of two plates of a 3-plate condenser on to the open ends of the Lecher-system conductors, or, where applicable, the direct immersion of the latter in a liquid dielectric is advisable. F. QUELON

538.566

5926. On the passage of electromagnetic waves through a plane-parallel crystal sheet. KH. YA. KHRISTOV. *Dokl. Akad. Nauk SSSR*, **81**, 553–6 (*No.* 4, 1951) *In Russian.*

Mathematical. The problem of reflection and

efraction of electromagnetic waves normally incident on the crystal sheet is examined. Account is taken of nterference with spherically symmetric waves emitted by the dipoles, 1 per cell, the incident wave being plane-polarized along a crystal axis. The system reduces to a finite system for which E, H and the dipole moments p can be calculated. J. JACOBS

538.566

5927. Determination of the velocity of short electromagnetic waves by interferometry. K. D. FROOME. *Proc. Roy. Soc. A*, **213**, 123–41 (*June* 5, 1952).

A new measurement of the velocity of electromagnetic radiation is described. The result has been obtained, using microwaves at a frequency of 24 005 Mc/s ($\lambda = 1{\cdot}25$ cm), with a form of interferometer which enables the free-space wavelength to be evaluated. Since the microwave frequency can also be ascertained, phase velocity is calculated from the product of frequency and wavelength. The most important aspect of the experiment is the application to the measured wavelength of a correction which arises from diffraction of the microwave beam. This correction is new to interferometry and is discussed in detail. The result obtained for the velocity, reduced to vacuum conditions, is $c_0 = 299\,792{\cdot}6 \pm 0{\cdot}7$ km/s. A.

538.566 , 535.42

A rigorous formulation of the classical diffraction problem. *See Abstr.* 5702

538.566 , 535.42

The diffraction of electromagnetic waves by a slit. *See Abstr.* 5703

538.566 : 621.396.671.4

5928. The radiation pattern of an antenna over a circular ground screen. J. E. STORER. *J. Appl. Phys.*, **23**, 588–93 (*May*, 1952).

In a previous paper [Abstr. 8058 (1951)] the author treated the problem of the input impedance of an aerial erected over a large circular screen. Using the formulation developed therein, an expression is obtained for the entire radiation pattern of an aerial over a large circular screen. The most important difference between the pattern of an aerial over a large screen and an aerial over an infinite screen is the presence of lobes over the aerial. From the expression for the radiation pattern, simple formulae are obtained for: (*a*) the number of lobes, (*b*) the angular position of the lobes, and (*c*) the angle, β_{max}, within which the lobes occur. One important result obtained is that $\theta_{max} \simeq d^{-\frac{1}{2}}$, where d is the diameter of the screen. It is apparent that the effects of a finite screen decrease very slowly as the diameter of the screen is increased. A.

538.566.2 : 621.396.11 : 621.396.812.3

5929. Anomalous variations in the angle of down-coming radio waves and their bearing on the fading of short wave signals. J. P. SRIVASTAVA AND V. D. RAJAN. *Indian J. Phys.*, **25**, 287–97 (*June*, 1951).

It has been found that there are often anomalous variations in the angles of arrival of the down-coming radio-waves from the inosphere. A detailed study of the variations of intensity of short-wave signals in the range between 16 m and 41 m, along with the simultaneous measurement of the angles of arrival of the down-coming waves, has therefore been made. The circumstances under which such anomalous variations resulting in abnormal values for the angle of arrival may be obtained, are discussed. It has been shown that when singly or doubly reflected waves are present, normal values of angles are obtained, which agree with the theoretically computed results. The anomalous variations and abnormal values of the angles have been explained to be due to the presence of ordinary and extraordinary rays arising from magneto-ionic splitting. This is borne out by the normal and fairly constant values of angle obtained when the extraordinary wave alone is present after disappearance of the ordinary wave component. A few examples of such observations have been given. A.

538.566.3

5930. Propagation of electromagnetic signals in an ionized gas. N. G. DENISOV. *Zh. Eksper. Teor. Fiz.*, **21**, 1354–63 (*No.* 12, 1951) *In Russian.*

The problem of the propagation of an electromagnetic signal in a homogeneous ionized medium was treated by Zhekulin (1938) and in a more general form, for inhomogeneous ionized media, by Ginzburg in his book on propagation of radiowaves in the ionosphere (1949). Ginzburg obtained an asymptotical solution for large group travels. This solution corresponds to the approximation of geometrical optics and is expressed by Fresnel integrals. The author deals with the homogeneous problem and obtains an accurate solution expressed by Lommel functions of two variables. When the integral representation of these functions is used, it is easy to obtain the asymptotic form of the solution which, as in Ginzburg's case, may be represented by Fresnel integrals. The asymptotic form of the solution describes the field of the main part of the signal which travels over considerable distances. In these cases comparatively simple formulae may be given for the envelope of the oscillations of the field, which simplifies the solution of practical problems. B. F. KRAUS

538.566.3 : 621.396.11

5931. Mechanics, geometric optics and ionospheric propagation. D. GRAFFI. *Nuovo Cim.*, **8**, 156–67 (*Suppl. No.* 2, 1951) *In Italian.*

It is first shown what relation exists between the motion of a wave-group of definite frequency in the ionosphere and the motion of a particle of unit mass and certain energy in a potential field. Without making too precise assumptions about the variation of electron density with height, the electromagnetic problem is worked out step by step as one in mechanics. The various theorems are demonstrated and the question of absorption treated. The discussion is carried out first for a flat earth and then extended to the more practical case. S. C. DUNN (R)

538.566.3 : 621.396.812.3

5932. Studies in fading of medium-wave radio signals. B. A. P. TANTRY AND S. R. KHASTGIR. *Indian J. Phys.*, **25**, 217–32 (*May*, 1951).

Intensity variations of the down-coming waves of

medium radio frequencies from Delhi, Dacca, Lahore and Vijayawada broadcasting stations as received at Banaras were studied in the evening and early night hours, there being no ground waves from these distant stations at the receiving point. Medium-wave signals from Lucknow, Patna and Allahabad radio stations were also received at Banaras and their intensity variations investigated. The following types of fading patterns were observed:

(i) Periodic or quasi-periodic fading of slow and quick periods. The former is attributed to the interference of the ordinary and extraordinary components of the wave in the ionosphere as described by Appleton and Beynon. The comparatively "quick" periodicity, which was also frequently observed, has been considered as due to the vertical movement of the ionospheric layer which usually takes place in the early morning or in the evening or early night hours. The Döppler-beat interpretation of this type of periodic fading is outlined and the expressions for the periodicity given. The vertical velocity of the ionospheric layer, as computed from the Döppler-beat consideration of the so-called "quick" periodicity, was found to be of the order of 3·5 m/sec during the evening or early night hours.

(ii) Random fading. The analysis showed that the actual distribution curve did not agree with the Rayleigh formula for random scattering; Rayleigh's formula is applicable to one down-coming wave only. With longer distances the existence of a number of waves following slightly different paths in the ionosphere may partly explain the discrepancy between the observed results and those computed from Rayleigh's formula. For more distant stations, more than one peak in the observed intensity distribution curve were observed. This must be due to the simultaneous single and double reflections from the *E*-layer. A.

MAGNETIC EFFECTS 538.6

538.632

5933. A new method permitting the measurement of the Hall effects in series and in parallel. A. L. PERRIER. *Helv. Phys. Acta*, **24**, 637–41 (*No.* 6, 1951) *In French.*

The Hall effect is measured between the inside and outside of a flat ring carrying an induced current due to the removal of a magnetic field, the Hall voltage being registered on a ballistic galvanometer. A concentric ring with radial slots and so no induced current or Hall effect, is used in series to eliminate contact, thermal and other parasitic voltages. Several such pairs of rings may be stacked together and connected in series or in parallel. The theory is given. D. H. WHIFFEN

538.652

5934. Magnetostriction of several heat-oriented ferrites. L. WEIL. *C.R. Acad. Sci.* [*Paris*] **234**, 1351–2 (*March* 24, 1952) *In French.*

The magnetostriction both parallel to and at right angles to the direction of orientation was measured for mixed ferrites of Co and Mg and of Co and Ni in various proportions. The ferrites remained orientable even for small concentrations of Co. G. L. WILSON

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

5935. Calculation of the generalized conductivity of heterogeneous systems. I. Two-phase matrix systems with non-elongated inclusions. V. I. ODELEVSKIĬ. *Zh. Tekh. Fiz.*, **21**, 667–77 (*No.* 6, 1951) *In Russian.*

This is essentially a methodological investigation aiming at the clarification of the character of specific problems associated with heteorgeneous substances and dealing with the selection of the appropriate mathematical methods for solving apparently similar but actually fundamentally different problems. The programme of the investigation is as follows: definition of the metric function of a heterogeneous system; investigation of a system with orientated cubic inclusions placed at the nodes of a simple cubic lattice (low and high concentrations treated separately); matrix structure with approximately equidistant inclusions; comparison with experimental results; 2-dimensional problem. B. F. KRAUL

539.11

5936. Calculation of the generalized conductivity of heterogeneous systems. II. Statistical mixtures of non-elongated particles. V. I. ODELEVSKIĬ. *Zh. Tekh. Fiz.*, **21**, 678–85 (*No.* 6, 1951) *In Russian.*

Various specific properties of heterogeneous systems are related to the geometrical structure of the system in different ways; e.g. density and specific volume have to do only with densities (specific vol.) and concentrations of the phases, but such properties as dielectric constant, electric and thermal conductivities and magnetic permeability (which may collectively be described as "generalized conductivity") also depend on phase geometry. This relation becomes more marked with increasing differences in the phase "conductivities." There are basically two different kinds of heterogeneous systems: the first, known as "matrix" type, is characterized by the fact that one of the phases forms the matrix in which disconnected particles of the others are buried, the character of the configuration remaining the same until the concentration of the matrix phase becomes zero. In such systems the phases are not equivalent geometrically and therefore a permutation of the phase indices in the analytical expression of the generalized conductivity leads to a basic variation of the theoretical value of the generalized conductivity. In the second type, the statistical mixture, the phases are geometrically equivalent, and therefore a commutation of the phase indices does not alter the character o

the function representing the generalized conductivity. The investigation considers the symmetrical formulae of Mosotti–Lorentz and Lichtenecker from this point of view and then discusses and demonstrates the correct way of calculating the dielectric constant of a n-phase statistical mixture with non-elongated isotropic phase elements. It is done in a way similar to that discussed in the first part of the paper, viz. by introducing an auxiliary system II of the same overall phase configuration, but of a dielectric constant reduced by a factor ε. The results are compared with experimental results obtained on pressed specimens of technical titanium dioxide and of barium titanate and show a nearly ideal agreement, whereas the curves calculated on the Lorentz and Lichtenecker formulae simply cannot be regarded as representing anything similar to the actual conditions. B. F. KRAUS

539.11

5937. Calculation of the generalized conductivity of heterogeneous systems. III. The polycrystal. V. I. ODELEVSKIĬ. *Zh. Tekh. Fiz.*, **21**, 1379–82 (*No.* 11, 1951) *In Russian.*

In the previous parts the conductivities of some types of two-phase and multiple-phase systems with isotropic elements have been treated; the present contribution deals with the "conductivity" of the simplest system with anisotropic elements, i.e. a single-phase monocrystal. The electrostatic problem is solved for component crystallites characterized by three principal values of the diel. const., with the restriction to non-elongated crystallite components, which for computation may be replaced by spheres. The method used consists in considering a single particle as contrasted with a surrounding medium of diel. const. ε. Furthermore, an auxiliary system II is introduced in which the diel. const. of the actual unique phase is reduced by a factor ε, against which the geometry of the phases is invariant; from the theory of dimensions it then follows that the diel. const. of the auxiliary system must also be reduced ε times as against the original system. Assuming that in the auxiliary system the resulting reaction field of the "pseudo-vacuum" acting on the particle considered vanishes on an average, the "external" polarizing field in the auxiliary system may be taken as equal to the average field E. If the diel. const. $\varepsilon^{(h)}$ are independent of the field strength ("linear case") the field E may be resolved in the usual way into its components along the principal axes of the particle considered and the corresponding induced moments summed up geometrically. For the generalized conductivities Λ, which may, in special cases, stand for diel. const. ε, active (γ) or complex electric conductivity (λ), magnetic permeability μ, or even thermal conductivity λ_T, a cubic equation results. For the special case $\Lambda^{(2)} = \Lambda^{(3)}$, the following relation for $m = \Lambda^{(1)}/\Lambda^{(2)}$ is obtained: $F = 4(m + 2)/3[1 + \sqrt{(1 + 8m)}]$. For $m = 2$ (case of rutile) the divergence between theoretical and experimental values is only 4%; for $m = 10$, it reaches 60%, but increases infinitely beyond $m = 100$ ($F = 4{\cdot}6$). However, with certain assumptions on the mechanism of the conduction, the conditions under which the formulae apply with satisfactory accuracy may be determined.

B. F. KRAUS

539.11

5938. The internal pressure of solids. R. O. DAVIES. Letter in *Phil. Mag.*, **43**, 473–4 (*April*, 1952).

Thermodynamic consequences of assuming $C_v = F(T/\Theta)$. See Abstr. 2881 (1951). R. O. DAVIES

539.11

5939. Proton magnetic resonance in solid cyclohexane. E. R. ANDREW AND R. G. EADES. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 371–2 (*May*, 1952).

A study and a discussion of the mean square line width and of the spin-lattice relaxation time between 100°K and the melting-point (279·6°K). L. PINCHERLE

539.11 : 548.7

5940. Electronic energy bands in crystals. R. H. PARMENTER. *Phys. Rev.*, **86**, 552–60 (*May* 15, 1952).

A study is made of the feasibility of calculating valence and excited electronic energy bands in crystals by making use of one-electron Bloch wave functions. The elements of the secular determinant for this method consist of Bloch sums of overlap and energy integrals. Although often used in evaluating these sums, the approximation of tight binding, which consists of neglecting integrals between non-neighbouring atoms of the crystal, is very poor for metals, semiconductors and valence crystals. By partially expanding each Bloch wave function in a three-dimensional Fourier series, these slowly convergent sums over ordinary space can be transformed into extremely rapidly convergent sums over momentum space. It can then be shown that, to an excellent approximation, the secular determinant vanishes identically. This peculiar behaviour results from the poorness of the atomic correspondence for valence electrons. By a suitable transformation, a new secular determinant can be formed which does not vanish identically and which is suitable for numerical calculations. It is found that this secular determinant is identical with that obtained in the method of orthogonalized plane waves (plane waves made orthogonal to the inner-core Bloch wave functions). Calculations are made on the Li crystal in order to test how rapidly the energy converges to its limiting value as the order of the secular determinant is increased. For the valence band, this convergence is rapid. The effective mass of the electron at the bottom of the valence band is found to be closer to that of the free electron than are those of previous calculations on Li. This is probably because of the use of a crystal potential here rather than an atomic potential. The former varies less rapidly than the latter over most of the unit cell of the crystal, and thus should result in a value of effective mass more nearly free-electron-like. Unlike previous calculations on Li, the computed value of the width of the filled portion of the valence band agrees excellently with experiment. By making use of calculated transition probabilities between the valence band and the 1s level, a theoretical curve is drawn of the shape of the soft X-ray K emission band of Li. The comparison with the shape of the experimental curve is only fair.

A.

539.11 : 548.736.1 : 539.32

5941. Electrostatic contribution to the elastic constants of solids with a diamond structure. E. P. WOHLFARTH. Letter in *Phil. Mag.*, **43**, 474–6 (*April*, 1952).

A calculation of the electrostatic contribution is carried out using Ewald's method. The constant $\frac{1}{2}(c_{11} - c_{12})$ is found to be negative. A calculation assuming central forces to act between nearest and next-nearest neighbours (Grüneisen law) again leads to a negative value of this constant. The Fermi energy contribution, assuming a quasi-free electron distribution for the full zone, also fails to stabilize the diamond lattice under this shear. It is tentatively concluded that the solids are stabilized by some contribution arising from a non-uniform charge distribution. E. P. WOHLFARTH

539.11 : 548.736.3

5942. The calculation of the dependence of the lattice constants of binary solid solutions on composition. A. N. ORLOV. *Zh. Eksper. Teor. Fiz.*, **21**, 1081–9 (*No.* 10, 1951) *In Russian.*

An expression is constructed for the lattice energy of a solid solution and its dependence on composition. Hence, a model is assumed in which the conduction electrons are distributed with constant density throughout the crystal and their interactions with ions and the mutual interactions of ions are calculated by approximate formulae. The possible co-existence at the absolute zero of phases, differing in structure and composition, in the system of alloys of two metals is explained. For low concentrations of a metal having a smaller ionic radius than the solvent, the lattice constant of the solution increases with concentration of solute as is found experimentally. A. L. MACKAY

539.11 : 548.736.3 : 539.32

5943. The theory of the elastic constants of binary solid solutions having cubic lattices. A. N. ORLOV. *Zh. Eksper. Teor. Fiz.*, **27**, 1090–6 (*No.* 10, 1951) *In Russian.*

See also preceding abstract. Elastic constants of a binary solid solution are calculated as functions of composition and agree with the experimental values when numerical constants are inserted. In alloys of the KRb type the bulk modulus is expected to change monotonically with composition. In solid solutions, as in pure metals, the sign of the constant of the anisotropic modulus of elasticity is positive, as is confirmed by experiment. In KRb-type solutions this constant does not depend on composition. All elastic constants can be calculated from measurements of the dependence of lattice constant on composition, the elastic constants of the pure components and one constant of the solid solution at one arbitrary composition. Au–Ag is taken as an example. A. L. MACKAY

MOLECULAR STRUCTURE 539.13

539.13

5944. Direct measurement of the molecular attraction as function of distance between surfaces. B. V. DERYAGIN AND I. I. ABRIKOSOVA. Letter in *Zh. Eksper. Teor. Fiz.*, **21**, 945–6 (*No.* 8, 1951) *In Russian.*

A glass or quartz plane sheet was attached to one arm of a balance connected to a photoelectric cell. As a similar convex surface approached and receded, hysteresis effects were observed. During approach the law is $F \propto H^{-3}$ (F = molecular attraction, H = least distance). J. JACOBS

539.13

5945. Exchange phenomena at large distances. A. HOURIET. *Helv. Phys. Acta*, **24**, 631–2 (*No.* 6, 1951) *In French.*

For large distances, a bound electron wavefunction has form $\sim \exp(-r/r_0)$, where $r_0 = \hbar/\sqrt{(2m^*E)}$, E being its binding energy, m^* its effective mass. For an atom in a crystal it is possible for r_0 to be 10–100 Å, so that unusually long-range interactions between atoms may then occur. R. H. DALITZ

539.13

5946. The application of the Hammett equation to the dissociation of aromatic free radicals. N. SCHWARTZ AND W. K. WILMARTH. Letter in *J. Chem. Phys.*, **20**, 748–9 (*April*, 1952).

The dissociation of tetrazanes is investigated and Hammett's equation tested. The compounds define a straight line if the experimental data are corrected to the same solvent and temperature. A. J. TAYLOR

539.132

5947. The approximations of molecular theory tested on LiH and BeH^+. I. FISCHER. *Ark. Fys.*, **5**, 349–76 (*Paper* 16, 1952).

A comprehensive investigation of wave functions and conditions for optimum combination of atomic orbits. Binding energies and electron distributions may be found using all electrons in strictly orthogonal orbits or valence electrons only; in the latter case ns orbits should be nodeless for $n > 1$. For molecules with partly ionic bonds Pauling's principle of maximum overlap is replaced by a condition of maximum penetration. J. JACOBS

539.132

5948. A quantum-mechanical treatment of F_2 binding. F. SCHLÖGL. *Z. Phys.*, **131**, 505–27 (*No.* 4, 1952) *In German.*

Using a wavefunction representing holes in closed atomic shells, the separations of the 12 lowest energy levels of the F_2 molecule are calculated by a perturbation method, starting from wavefunctions of non-interacting F atoms. Absolute values are then deduced by using a Morse potential for the ground state: agreement of the levels with available data is satisfactory. R. H. DALITZ

539.132

5949. Chemical valence forces and binding energy calculations. C. P. MUELLER AND H. EYRING. *Proc. Nat. Acad. Sci.* [*Wash.*] **38**, 149–54 (*March*, 1952).

Calculations with semi-localized orbitals for H_2 and HF lead to much improved numerical results. For such highly ionic bonds as HF semi-localized and molecular orbitals differ appreciably. J. JACOBS

539.132 : 536.654

5950. On an interpretation of the limits of predissociation in the spectrum of carbon monoxide and the latent heat of sublimation of graphite. P. K. SEN GUPTA. *Indian J. Phys.*, **25**, 267–73 (*June*, 1951).

From a survey of the available data on predissociation phenomena in carbon monoxide, the energy of dissociation into $C(^3P)$ and $O(^3P)$ atoms has been found to be 8·87 volts. This assignment gives the latent heat of sublimation of graphite into $C(^3P)$ atoms as 118·74 kcal. These figures give a satisfactory account of the known experimental results. It has also been shown that the average energy of the C–H bond in methane, calculated with the results for graphite, is of the right order. A.

539.132

5951. The fundamental frequencies of F.CN. V. J. O. THOMAS. Letter in *J. Chem. Phys.*, **20**, 920 (*May*, 1952).

Extrapolating from values for halogen compounds, theoretical values for bond distances and force constants are obtained. These give predicted frequencies $\nu(CN) = 2294$, $\nu(CF) = 1052\ cm^{-1}$. J. JACOBS

539.132

5952. Vibration-rotation bands of methane. D. R. J. BOYD, H. W. THOMPSON AND R. L. WILLIAMS. *Proc. Roy. Soc. A*, **213**, 42–54 (*June* 5, 1952).

The i.r. absorption spectrum of CH_4^{12} in the region of 3 μ has been reinvestigated with higher resolving power than has been used previously. A very complex system of overlapping vibration bands has been revealed. The rotational fine structure of these bands has been partially analysed, particularly having regard to the Coriolis interactions which occur in this case. The corresponding absorption bands of CH_4^{13} have also been examined. A.

539.132

5953. Coriolis interaction between vibration and rotation in symmetric top molecules. D. R. J. BOYD AND H. C. LONGUET-HIGGINS. *Proc. Roy. Soc. A*, **213**, 55–73 (*June* 5, 1952).

The effect of Coriolis perturbations on the perpendicular i.r. bands of symmetric top molecules is studied in the first approximation. The sum of the Coriolis coefficients for the vibrations in any symmetry class is shown to assume an extremely simple form, and its value is given for the general case. A straightforward method is described for the calculation of first-order Coriolis coefficients, and rules are derived whereby the rotational spacing of an overtone or combination band may be calculated from the Coriolis coefficients of the component vibrations. A.

539.132

5954. Resonance energy in carbonium ions. J. HALPERN. Letter in *J. Chem. Phys.*, **20**, 744–5 (*April*, 1952).

From measurements of appearance potentials it is concluded that resonance energies of allyl and propyl ions are 58–59 kcal, of phenyl-dimethyl and cyclohexyl dimethyl-carbonyl ions 81–84 kcal. Thus π-conjugation energy in unsaturated radicals $\gg$ hyperconjugation energy in corresponding saturated radicals. J. JACOBS

539.132

5955. Resonance energy of gaseous ions—reply to Halpern. J. L. FRANKLIN AND H. E. LUMPKIN. Letter in *J. Chem. Phys.*, **20**, 745–6 (*April*, 1952).

Halpern explains the high stability as due to resonance. The stabilization energy would then be much reduced on substitution for a H of the CH_3 group by a high ionization potential atom. This does not seem to be the case. J. JACOBS

539.132

5956. The ionization potential of the CF_3 radical and some fluorocarbon bond energies obtained by electron impact. V. H. DIBELER, R. M. REESE AND F. L. MOHLER. Letter in *J. Chem. Phys.*, **20**, 761 (*April*, 1952).

Subtracting the ionization potential of the CH_3 radical from the appearance potential of CH_3^+ in CH_3CF_3 gave 5·1 eV for the C–C bond energy, and 5·4 eV in the case of C_2F_6. J. JACOBS

539.132

5957. Refined free electron model of porphine and tetrahydroporphine. T. NAKAJIMA AND H. KON. Letter in *J. Chem. Phys.*, **20**, 750–2 (*April*, 1952).

The complete π-electron path is accounted for by combining free electron wavefunctions pertaining to different regions of the molecular system in accordance with symmetry considerations. Nitrogen atoms are represented by potential wells of arbitrary length and depth. Comparison is made with experimental results and with those obtained by the LCAOMO method. H. H. GREENWOOD

539.132 , 539.153.4

5958. A comparative survey of approximate ground state wave functions of helium atom and hydrogen molecule. R. S. MULLIKEN. *Proc. Nat. Acad. Sci. [Wash.]* **38**, 160–6 (*March*, 1952).

For best $(\sigma\bar{\sigma})$ functions of H_2, polarized atomic orbitals (PAO) may be used, which need not belong to irreducible representations of the molecular symmetry group. Indeed, the correlation energy is reduced by letting the electrons move in considerably different orbitals, although this increases their non-orthogonality. J. JACOBS

539.132 : 541.5

5959. The molecular orbital theory of chemical valency. X. A method of calculating the ionization potentials of conjugated molecules. G. G. HALL. *Proc. Roy. Soc. A*, **213**, 102–13 (*June* 5, 1952).

For Pt IX, see Abstr. 2888 (1952). The orbitals of the ground state of a flat conjugated molecule are shown to be closely related to the orbitals of a certain excited state of the molecule. In this state, which is named the *standard excited state*, all the mobile electrons are in singly-occupied antisymmetrical or π orbitals and have their spins parallel. These antisymmetrical orbitals can be transformed into equivalent orbitals which are each localized around one atom and so form a suitable basis for a method of calculating the ionization potentials of conjugated molecules. To illustrate the form of the equations obtained, the pyridine and aniline molecules are considered. A.

539.132 : 541.5

5960. The molecular orbital theory of chemical valency. XI. Bond energies, resonance energies and triplet state energies. G. G. HALL. *Proc. Roy. Soc. A*, **213**, 113–23 (*June* 5, 1952).

The expression for the total energy of a saturated molecule is discussed. It is shown that it can be written as the sum of suitably defined bond energies. The total energy of a conjugated molecule is not additive but can be expressed as a sum of bond energies together with a resonance energy which can be calculated by means of the standard excited state approximation. For hydrocarbon molecules, by a series of coincidences, this method leads to the same expression for the resonance energy as the Hückel method. A method of calculating the energies of some of the ground state-triplet transitions of conjugated molecules is also described. The energy of the phosphorescence transition is calculated for some hydrocarbon molecules and is in good agreement with experiment. A.

539.133

5961. The structure of the molecules PH_3, AsH_3, and SbH_3. H. H. NIELSEN. Letter in *J. Chem. Phys.*, **20**, 759 (*April*, 1952).

The vibration frequencies ν_1 and ν_3, and also ν_2 and ν_4 of these molecules, are coupled by Coriolis interactions. The Coriolis coupling coefficients and the angles and atomic distances of the molecules are calculated quantum mechanically. There is good agreement with experimental values. A. J. TAYLOR

539.133

5962. Theory of the ozone molecule. B. T. DARLING AND J. A. WEISS. Letter in *J. Chem. Phys.*, **20**, 747–8 (*April*, 1952).

An analysis is developed which satisfies the conditions that the three existing equivalent equilibrium configurations be accounted for and that the wave functions be symmetrical under permutations of the atoms. The molecule also possesses more symmetry than any geometrical point-group. Values are calculated for the lowest vibrational states. It is suggested that either ozone is obtuse-angled isosceles with a considerable difference between the two bigger moments of inertia, or that it is not exactly isosceles. A. J. TAYLOR

539.133

5963. The structure of dimethyl-triacetylene. G. A. JEFFREY AND J. S. ROLLETT. *Proc. Roy. Soc. A*, **213**, 86–101 (*June* 5, 1952).

$H_3C—C{\equiv}C—C{\equiv}C—C{\equiv}C—CH_3$ crystallizes with one molecule in a rhombohedral cell of dimensions $a = 5{\cdot}69$ Å, $\alpha = 70°\,58'$. The space group is $R\bar{3}m$, and with the centrosymmetrical molecule extended along the triad axis four parameters define the positions of the carbon atoms. Because of the simplicity of the crystal structure, the X-ray analysis was refined to a degree of detail and accuracy not generally possible with organic molecular structures. The Fourier methods of refinement were applied independently to the $(0, z)$ projection with $(h0\bar{h}l)$ terms and the $(0, 0, z)$ line with $(hkil)$ terms. A sectional synthesis at $(0, y, z)$ with $(F_{obs.} - F_{calc.})$ terms revealed no marked anisotropy of thermal vibration in the carbon atoms and showed a clearly defined peak of $0{\cdot}35$ eÅ^{-3} corresponding to the location of the hydrogens on a circle coaxial with the molecule. A section at (x, y, z_H) revealed no evidence of other than a freely rotating methyl group. The agreement between observed and calculated structure factors was significantly improved by an allowance for the distribution of the π-bonding electrons. The Fourier syntheses were corrected for termination-of-series errors, after which the heights of the carbon peaks were identical within $0{\cdot}06$ eÅ^{-3}, and the parameters from the two- and three-dimensional data were consistent within $0{\cdot}006$ Å. The standard deviations of the carbon atomic co-ordinates calculated by the method of Cruickshank were $0{\cdot}010$ and $0{\cdot}005$ Å for projection and line respectively. The molecular dimensions from the three-dimensional analysis are: —C≡C— $1{\cdot}19_9$ Å, C—C $1{\cdot}37_5$ Å, —C≡C— $1{\cdot}19_2$ Å, C—CH_3 $1{\cdot}46_6$ Å, C—H ~ $1{\cdot}0$ Å, C—$\hat{C}$—H 105°. These data agree within experimental error with the spectroscopic measurements for the corresponding bond lengths in acetylene and methyl acetylene and the electron diffraction results for diacetylene and dimethyl acetylene. Assuming the validity of the π-bond order-length relationship of Lennard-Jones and Coulson in the region of the triple bond, there is a significant discrepancy between theory and experiment for the length of the central link. A.

539.133

5964. Contribution to the infra-red study of the valence band C=O in polycyclic compounds. M.-L. JOSIEN AND N. FUSON. *Bull. Soc. Chim. France*, **19** 389–97 (*March–April*, 1952) *In French.*

The frequency of this band was measured for about eighty compounds. The various factors determining the frequency are discussed, such as the influences of phase, electronegativity of substituents, and the effect of several C=O groups in the molecule; it is dependent upon the order of the C=O bond, upon the oxidation-reduction potential of the compound and on its degree of saturation. The position of this band can give indications of the electronic structure of molecules. A. J. TAYLOR

539.13

5965. Study of the valence frequency of the carbonyl group in some quinones. M.-L. JOSIEN AND N. FUSON. *C.R. Acad. Sci.* [*Paris*] **234**, 1680–1 (*April* 21, 1952) *In French.*

This frequency is strongly dependent upon the molecular structure; it is lower in paraquinones than in orthoquinones. Addition of benzene nuclei to paraquinone in a straight line causes it to increase but if the new nucleus occurs at an angle, the frequency decreases. A number of experimental spectra data support these statements. A. J. TAYLOR

539.13

5966. Electrical polarizability as a criterion for molecular wave functions. J. A. ABBOTT AND H. C. BOLTON. Letter in *J. Chem. Phys.*, **20**, 762–3 (*April* 1952).

The wavefunctions used included 2 parameters, a scale factor and a hybridization factor. These can be adjusted from known longitudinal and transverse polarizabilities. J. JACOB

539.133 : 537.226.1

967. Dipole moments from dielectric data on polar quids. J. D. HOFFMAN. Letter in *J. Chem. Phys.*, 0, 740 (*April*, 1952).

It is shown by comparison of the equations of nsager (1936) and Kirkwood (1939) that μ_1^2 (μ_1 = ipole moment of a molecule in a pure polar liquid), hen plotted against $1/T$ yields an intercept with the rdinate μ_0, which appears in Kirkwood's equation nd which is very close to the observed gas moment. xperimental data support the statement. A. J. TAYLOR

539.133

968. The intensities of absorption bands in the ethyl halides. G. M. BARROW AND D. C. MCKEAN. *roc. Roy. Soc. A*, **213**, 27–41 (*June* 5, 1952).

The method involving pressure broadening of ands described by Wilson was used. The force onstants have been determined on the basis of a orce field previously suggested by Noether, and the ansformations from normal to symmetry co-rdinates have been calculated. After allowing for ne effects of the overlapping of bands and of Fermi esonance, the intensities have been interpreted in erms of bond moments μ and of their derivatives $\partial\mu/\partial r$, assumed to be vectors directed along the bonds. he results show that values of $\partial\mu/\partial r_{CH}$ obtained om the A_1 class of vibration vary from about $\cdot 7\times10^{-10}$ unit (Debye/Å) for methyl fluoride to bout $0\cdot9+10^{-10}$ for methyl iodide showing a niform trend along the series. By contrast, the alues in the E class range from about $0\cdot6\times10^{-10}$ for ethyl fluoride to less than $0\cdot2\times10^{-10}$ for the iodide. alues of μ_{CH} in general lie around 0·4 D. $\partial\mu/\partial r_{CX}$ ncreases in value from 1×10^{-10} unit in methyl iodide o the high value of $4\cdot7\times10^{-10}$ unit in methyl fluoride. here is some indication that its sign is positive. alues of μ_{CF} and of μ_{CCl} are obtained which are onsiderably higher than the total molecular dipole ioment. Some tentative suggestions are put forward o account for the magnitudes of the polar properties ound. A.

539.133

969. A theoretical study of the dipole moment of niline. I. FISCHER. *Ark. Fys.*, **5**, 377–89 (*Paper* 17, 952).

The self-consistent field M.O. method was used to etermine ground state orbitals for 2 $p\pi$-electrons. he dipole moment is in agreement with the experi-ental value; and has approximately equal contri-utions from the lone pair migration and the inductive ffect of the NH_2-group. J. JACOBS

539.133 : 541.64

970. Shape and mobility of chain molecules and eir meaning for the states of orientation in high olymers. H. A. STUART. *Z. angew. Phys.*, **7**, 29–37 *No.* 1, 1952) *In German.*

A general survey is given of the problems presented y these compounds. Methods for determining the ape and size of the molecules in solution are iscussed. Molecules with molecular weight $> 10^6$ an be observed by electron microscope. Hydro-ynamic methods might be applied in principle for naller molecules, but quantitative results have not et been attained. By the method of light scattering the size of polymers can be found from the distribution of intensities. When the molecular weight increases, the measured mean length (distance between the end-points of the molecule) becomes relatively smaller because of the entanglement of the chain. Because of this effect different models should be used for calculation. The mean lengths vary in different solvents: when the solubility is low, the interaction between chains and solvent is small compared with that between chain segments among themselves; this causes them to entangle more than in a good solvent. The mean length is also dependent upon temperature, but reliable experimental data are not available. Polymer crystals usually do not have a sharp melting-point, as different segments of one molecule may melt independently, thereby causing anomalies in entropy. Many solid polymers are partly amorphous. The orientation in the crystals is determined by the arrangement of the segments as well as by an intermolecular texture. A. J. TAYLOR

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

5971. The di-neutron periods of pure elements. I. H. WATZLAWEK. *Öst. Ingen.-Arch.*, **5**, 304–10 (*No.* 4, 1951) *In German.*

Plots of the abundances of elements attempting to show the special importance of the number of neutrons in a nucleus which are left unpaired in α-particles. W. J. SWIATECKI

539.152.1

5972. Quantization of the radiation processes from a nuclear drop. W. JEKELI. *Z. Phys.*, **131**, 481–7 (*No.* 4, 1952) *In German.*

The quantization of the oscillations of an incompressible charged liquid drop is carried out in spherical polar co-ordinates. Matrix elements of the interaction energy between the drop and the radiation field are calculated, showing the conservation of angular momentum, and the corresponding transition probabilities are obtained. R. H. DALITZ

539.152.1

5973. The deepest states of the ground configuration of even-even nuclei. P. STÄHELIN AND P. PREISWERK. *Helv. Phys. Acta*, **24**, 623–5 (*No.* 6, 1952) *In German.*

An examination of the energies of the lowest excited states shows regularities related to the shell structure of the nucleus. In particular, two different types of excitation may be recognized. L. PINCHERLE

539.152.1

5974. Charge distribution in nuclei from X-ray fine structure. A. L. SCHAWLOW AND C. H. TOWNES. *Science*, **115**, 284–5 (*March* 14, 1952).

This can be obtained from the separation of the L_{II} and L_{III} X-ray levels, i.e. the difference in binding energy of a $2p_{\frac{1}{2}}$ and a $2p_{\frac{3}{2}}$ electron. From the difference of the values of the fine structure constant, as determined from X-ray fine structure splittings, and from other accurate methods, it is concluded that the charge is either uniformly distributed in the heavier nuclei or slighter denser towards the surface. J. HUGHES

539.152.1

5975. On the definition of virtual levels of atomic nuclei and the derivation of the dispersion formula. J. HUMBLET. *Mém. Soc. Roy. Sci. Liège*, **12**, 114 *pp.* (*No.* 4, 1952) *In French.*

The general aim is to establish a convergent expansion for the one-particle problem with a view to an extension to the case of many particles. Starting with the theory of Kapur and Peierls (1938) and Siegert (1939) an expansion of the expression for the cross-section is considered using a particular application of the theorem of Mittag–Leffler concerning meromorphic functions in place of the eigenfunction expansion of Kapur and Peierls. The problem of the perturbation of virtual levels is studied and applied to the question of a virtual ^1S level of the deuteron. It is also shown that first terms of the expansion for the effective cross-section could correspond equally well to the formulae of Bethe–Peierls and Breit–Wigner. A critical comparison of the principal current definitions of virtual levels is given.

W. J. SWIATECKI

539.152.1

5976. *jj*-Coupling in nuclei. B. H. FLOWERS. Letter in *Phys. Rev.*, **86**, 254 (*April* 15, 1952).

Using group theory, the wave functions, properly antisymmetrized and characterized according to seniority, have been obtained for all the states of the configurations of 2, 3 and 4 particles of a given kind, for $j = 3/2$, $5/2$ and $7/2$. Various interesting consequences regarding the lowest states of nuclei are discussed. L. PINCHERLE

539.152.1

5977. The saturation property of nuclear forces. H. KANAZAWA. Letter in *Phys. Rev.*, **86**, 428 (*May* 1, 1952).

For a neutral scalar meson field, a g^2-potential is calculated for two nucleons within a Fermi gas of nucleons. The expectation value of the potential energy of the Fermi gas contains only saturating terms, when calculated with this nucleon-nucleon potential. R. H. DALITZ

539.152.1

5978. The emission of deuterons from the nucleus. A. G. W. CAMERON. Letter in *Phys. Rev.*, **86**, 435 (*May* 1, 1952).

An experiment is suggested to test the hypothesis that radially polarized deuterons are more easily emitted. J. J. WILKINS

539.152.1 : 535.338.333

5979. Spectroscopic isotope shift and nuclear shell structure. G. BREIT. Letter in *Phys. Rev.*, **86**, 254 (*April* 15, 1952).

A discussion on whether the anomalies in the isotope shift at "magic numbers" indicate that the centrifugal barrier associated with high values of the azimuthal quantum number contributes to making the usual shell structure quantum numbers "good" quantum numbers. L. PINCHERLE

539.152.1 : 535.338.333

5980. Magic numbers and the isotope shift in atomic spectra of heavy elements. P. BRIX AND H. KOPFERMAN. Letter in *Phys. Rev.*, **85**, 1050 (*March* 15, 1952).

A plot of the ratio of experimental over theoretical isotope shift against neutron number shows a pronounced rise at $N = 82$ and possibly at $N = 126$ and 50. W. J. SWIATECKI

539.152.1 : 539.165.3

5981. β-disintegrations and nuclear structure. I. Theoretical considerations: nuclear structure. R. NATAF AND R. BOUCHEZ. *J. Phys. Radium*, **13**, 81–99 (*Feb.*, 1952) *In French.*

It is attempted to compare the shell model of the nucleus with experimental data on β-disintegrations. In this first part an orbital momentum is introduced for the nucleus. The Russell–Saunders coupling is not complete, mainly because of non-central forces, and several (LS)-configurations must be considered; it is assumed that the most important of these configurations have the same parity as the nucleus as a whole. These hypotheses allow an interpretation of most magnetic moments. A possible series of nuclear levels is discussed, which may be different for neutrons and protons. L. PINCHERLE

539.152.2

5982. The nuclear magnetic moments of arsenic and titanium. C. D. JEFFRIES, H. LÖLIGER AND H. H. STAUB. *Helv. Phys. Acta*, **24**, 643–4 (*No.* 6, 1951) *In German.*

Nuclear induction measurements on As as AsO_4^{3-} or AsS_4^{3-} gave the nuclear magnetic moment of As (uncorrected for diamagnetism) as $+1{\cdot}4350 \pm 0{\cdot}000$ nuclear magnetons. For Ti, as $TiCl_4$ or $TiBr_4$, the value was $-1{\cdot}101$ nuclear magnetons, assuming spin of 7/2; it is not certain to which of the isotopes Ti^{47}, Ti^{49} this belongs. A. O. STANESBY

539.152.2

5983. Magic numbers and nuclear magnetic moments. G. J. BÉNÉ. *J. Phys. Radium*, **13**, 161–6 (*March*, 1952) *In French.*

The various theories which have attempted to explain the observed regularities in nuclear magnetic moments are reviewed and discussed. It is shown that it is now often possible to forecast values of unknown magnetic moments with fair accuracy.

L. PINCHERLE

539.152.2

5984. Magnetic moment of Se^{77}. S. S. DHARMATTI AND H. E. WEAVER, JR. Letter in *Phys. Rev.*, **86**, 22 (*April* 15, 1952).

$\mu(Se^{77}) = \pm 0{\cdot}53326 \pm 0{\cdot}00005$. L. PINCHERLE

539.152.2 : 538.22

5985. Nuclear spins of samarium 147 and 149. G. S. BOGLE AND H. E. D. SCOVIL. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 368–9 (*May*, 1952).

By means of paramagnetic resonance measurements on Sm ethyl sulphate the spin was found to be 7/2 in both cases. The ratio of the nuclear magnetic moments, given by the ratio of the widths of the hfs groups was found to be $\mu^{147}/\mu^{149} = 1{\cdot}222 \pm 0{\cdot}008$.

L. PINCHERLE

539.152.2 : 538.22

5986. The paramagnetism of samarium ethyl sulphate: theory. R. J. ELLIOTT AND K. W. H. STEVENS. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 370–1 (*May*, 1952).

It is shown that conventional theory accounts

fairly well for the results reported in the preceding abstract. One may tentatively predict that all isotopes with an odd number of neutrons between 83 and 99 will have spin 7/2, or just possibly 9/2.

L. PINCHERLE

539.152.2 : 535.338.332

Hyperfine structure and nuclear moments of Xe^{129} and Xe^{131}. *See Abstr.* 5657

539.153

5987. On the problem of extinction in the theory of bound particles. V. I. GRIGORYEV. *Zh. Eksper. Teor. Fiz.*, **21**, 1310–12 (*No.* 11, 1951) *In Russian.*

Apart from the natural spread of atomic energy levels in spontaneous and induced transitions, an effective shift is obtained due to extinction. These shifts differ for different energy levels, being proportional to transition probabilities. This shift is smaller by 5 orders of magnitude than that calculated by Bethe. J. JACOBS

539.153

5988. Observations on the He I isoelectronic sequence. B. EDLÉN. *Ark. Fys.*, **4**, 441–53 (*Paper* 28, 1952).

Some new wavelength data for Be III, B IV, C V, O VII and F VIII are presented. An empirical formula for the structure of $1s2p^3P_{2,1,0}$ is derived from observations in the five elements from He to C and compared with theory. The factors determining the intensity of the transition $1s^2\,{}^1S - 1s2p^3P_1$ are discussed with the conclusion that its identification, which had been subject to some doubts, is confirmed for the elements from B to Al. Interpolation formulae for the wavenumbers of certain transitions and terms are derived and utilized in the calculation of the triplet term systems. Complete term tables are compiled for Be III, B IV, C V, N VI, O VII, F VIII, Mg XI and Al XII. Finally, a discussion of the evidence for a "Lamb shift" in $1s^2\,{}^1S$ leads to an "observed" shift of $(0{\cdot}043 \pm 0{\cdot}006)R\alpha^2Z^4$. A.

539.153

5989. The energy levels of heavy atoms. Y. CAUCHOIS. *J. Phys. Radium*, **13**, 113–21 (*March*, 1952) *In French.*

A critical compilation from X-ray data for the elements $Z = 70$–92 (Yb–U), except 84 (Po), 85 (At), 86 (Em), 87 (Fr) and 89 (Ac). A. O. STANESBY

539.153

5990. Electrodynamic corrections to the fine structure of positronium. R. KARPLUS AND A. KLEIN. Letter in *Phys. Rev.*, **86**, 257 (*April* 15, 1952).

A perturbation calculation, using an operator similar to that of Bethe and Salpeter, except for the occurrence of a term that describes the virtual annihilation force, leads to a theoretical 1^3S–1^1S separation of $2{\cdot}0332 \times 10^5$ Mc/s (experimental 2·037).

L. PINCHERLE

539.153

5991. Zeeman effect and hyperfine splitting of positronium. M. DEUTSCH AND S. C. BROWN. Letter in *Phys. Rev.*, **85**, 1047–8 (*March* 15, 1952).

The line $(1, \pm1) \rightarrow (1, 0)$ was observed in a field of 9000 gauss at a frequency of 3000 Mc/s; the transition was detected by the increase, at resonance, of two-photon annihilation relative to the three-photon process. The h.f. splitting $\Delta\nu$ was found to be $2{\cdot}032 \pm 0{\cdot}003 \times 10^5$ Mc/s (theoretical value $2{\cdot}044 \times 10^5$). With this value of $\Delta\nu$ the theoretical position of the line (without radiative corrections) differs by 1200 ± 300 Mc/s from the observed position.

L. PINCHERLE

539.153

5992. Interaction of configurations in atoms of beryllium type. A. P. YUTSIS AND V. J. KAVETSKIS. *Zh. Eksper. Teor. Fiz.*, **21**, 1139–45 (*No.* 10, 1951) *In Russian.*

Fock wavefunctions and configuration interaction give agreement with experimental data to within 0·02 a.u. The influence of interaction increases from $-0{\cdot}042$ a.u. (Be) to $-0{\cdot}10$ a.u. (O^{+4}). Negative ions of Na and K are stable, but not that of Li, as the neutral atom ground state is of lower energy.

J. JACOBS

539.153

5993. A new "double resonance" method for investigating atomic energy levels. Application to Hg^3P_1. J. BROSSEL AND F. BITTER. *Phys. Rev.*, **86**, 308–16 (*May* 1, 1952).

Excitation of atoms in a vapour by polarized light produces unequal population of the magnetic sublevels of the excited state. The emitted optical resonance radiation is therefore partly polarized. The application of r.f. or microwave fields at a magnetic resonance frequency will induce transitions between sublevels of the excited state. The degree of polarization of the emitted optical resonance radiation is altered when the magnetic resonance condition is fulfilled. As suggested by Brossel and Kastler, this effect may be used to reveal the structure of the energy level. A detailed theory applicable to, and experiments on the $^3P_1$ state of all the isotopes of Hg are reported. The results obtained indicate that double resonance phenomena constitute a valuable new tool for investigating the structure of atomic energy levels. The mean life of the $^3P_1$ state is shown by observations on the resonance line widths to be $1{\cdot}55 \times 10^{-7}$ sec for all the isotopes. The g-factor of the $^3P_1$ state for isotopes with zero spin, measured in terms of the proton g-factor, is $1{\cdot}4838 \pm 0{\cdot}0004$. A.

539.153

5994. An attempt to produce nuclear orientation in mercury vapor. F. BITTER AND J. BROSSEL. Letter in *Phys. Rev.*, **85**, 1051 (*March* 15, 1952).

The use for this purpose of polarized light as suggested by Kastler [Abstr. 8171 (1950)] gave, within a few %, a null result for the excess in the population of the $m = \frac{1}{2}$ over the $m = -\frac{1}{2}$ ground level of Hg^{199}. W. J. SWIATECKI

539.153.4

5995. Superposition of configurations: the helium atom. G. R. TAYLOR AND R. G. PARR. *Proc. Nat. Acad. Sci.* [*Wash.*] **38**, 154–60 (*March*, 1952).

Total electronic correlation energy is a sum of angular and radial correlation energies. In the helium atom the correlation energy is 62% angular, 38% radial; the corresponding best wavefunction includes $2p$, $3d$ and $4f$ electron contributions. J. JACOBS

539.153.4

5996. The application of variational methods to atomic scattering problems. II. Impact excitation of the 2*s* level of atomic hydrogen—distorted wave treatment. G. A. ERSKINE AND H. S. W. MASSEY. *Proc. Roy. Soc. A*, **212**, 521–30 (*May* 22, 1952).

For Pt I, see Abstr. 3572 (1951). The cross-section for excitation of the 2*S* level of atomic H by electrons is calculated using the distorted wave method with full allowance for exchange. The distorted wave functions used in the calculations are determined by Hulthèn's variational method. The initial wavefunctions, representing the motion of an electron in the field of a normal atom with allowance for exchange, are taken to be those calculated by Massey and Moiseiwitsch (1950). The final wavefunctions, representing the motion of an electron in the field of a hydrogen atom in the 2*S* state, have been obtained by a modification of the same method. Exchange effects are found to be less important in determining the forms of these wavefunctions. The cross-sections obtained are considerably smaller than those calculated by the Born–Oppenheimer method, in which the electron wavefunctions are undistorted plane waves. This is largely because the symmetrical cross-section, which has the greater weight in determining the mean cross-section, is much greater than the antisymmetrical according to the Born–Oppenheimer method, but the reverse is true if distortion is allowed for. In no case does the distorted wave method give results exceeding the theoretical upper limit, whereas with plane waves this limit is exceeded at certain electron energies by the symmetrical cross-section. A.

539.155.2

5997. On the separation of isotopes by gas diffusion. W. GROTH AND P. HARTECK. *Z. phys. Chem.*, **199**, 114–24 (*Jan.*, 1952) *In German.*

Calculation from Chapman's theory of the coefficients of mutual diffusion of various binary combinations of H_2, D_2, Ne, A, Kr, Xe in first and second approximation and their derivative with respect to concentration at low concentrations of either component. The change of the diffusion coefficient resulting from a 10% change in mass of either the heavier or the lighter is also given, showing that an efficient separation occurs only if the isotope mixture diffuses into a heavier gas. The results are illustrated by some experiments in which the progress of diffusion is followed continuously and single-process isotope separation is observed. H. LONDON

539.155.2

5998. On the calculation of the equilibrium amount of β-active carbon in the atmosphere from data on cosmic-ray neutrons. G. PFOTZER. *Z. Naturforsch.*, **7a**, 145–9 (*Feb.*, 1952) *In German.*

Calculations can be made using measurements of (*a*) the counting rate of unscreened counters; (*b*) (less accurately) the change in counting rate on inserting a Cd absorber (Cd-difference). The production rate of C^{14} is 1·9–2·5 atoms sec^{-1} cm^{-2} of air, giving an equilibrium amount of $1 \cdot 1–1 \cdot 5 \times 10^{-11}$ g cm^{-2} earth's surface. The corresponding C^{14} activity in organic biological substances is 13·5–18 β-disintegrations min^{-1} g^{-1} C, in agreement with the measurements of Anderson and Libby [Abstr. 2935 (1951)].

A. O. STANESBY

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16 : 614.48

Control and removal of radioactive contamination in laboratories. *See Abstr.* 6235

539.16.08

5999. On the measurement of radioactivity as an analytical investigation method for mineral waters. W. KOLB. *Diss. E.T.H. Zürich, No.* 1875, 51 *pp* (1951) *In German.*

Previously used methods are described first. To measure radon or thoron in water, a circulation system with an ionization chamber was used, which did not require a calibrating solution. A quartz fibre electrometer with a capacitance of 1·5 *pF* permitted activities down to 360 $\mu\mu$C to be measured. A current of 1 $\mu\mu$A from thoron (5×10^{-3} OR units) could be detected in the presence of 30 $\mu\mu$A from radon (0·036 μC). The waters of several spas were measured. A method for measuring solid radioactive substances (such as sediments) was also developed, using a G.M. counter. F. R. HOL

539.16.08 : 537.542

6000. Determination of specific activities of C^{14}-labeled organic compounds with a water-soluble liquid scintillator. E. C. FARMER AND I. A. BERSTEIN. *Science*, **115**, 460–1 (*April* 25, 1952).

By using ½% (by weight) solution of *p*-terphenyl in *p*-dioxane as scintillator, the C^{14} content of aqueous solutions of organic compounds added to the scintillation liquid (standard concentration 5% water in *p*-dioxane) can be determined. Counting efficiency is not seriously impaired by the presence of 20% of water. G. F. J. GARLICK

539.16.08 : 614.89

Radiological monitoring methods and instruments. *See Abstr.* 6238

539.16

6001. The missing heavy elements. N. K. SAHA AND J. VERMA. *Indian J. Phys.*, **25**, 410–16 (*Sept.* 1951).

With a view to analysing the possible causes of (1) absence of natural elements having atomic number $Z > 92$ and (2) non-occurrence of isotopes of the $(4n + 1)$ type among the natural elements, the known isotopes of 92 U and of the transuranium elements from 93 Np to 96 Cm are compiled from the recent works of Seaborg and others. A plot of the Heisenberg energy surfaces for the observed α-emitting nuclei on a neutron-proton diagram reveals the probable existence of an energy-high in the region of lower isotopes of U, Np and Pu. Natural extinction of these isotopes by short-life radioactive α-decay is therefore, considered possible. The mean life of spontaneous fission of heavy isotopes is also calculated from Turner's extension of Bohr and Wheeler's theory of nuclear fission. The results show that the elements 95 Am and higher would have too short mean fission life to survive in nature. The higher isotopes of 93 Np and 94 Pu present difficulties, as neither their radioactive decay period nor spontaneous fission life seems to be short enough to account for their non-existence. The processes of production of these

otopes by the observed nuclear reactions in the boratory are compared with the natural processes f formation of heavy elements in the interior of ense stars as postulated by Weissäcker, Mayer and eller, and others. It is pointed out that, unlike in ie laboratory reactions, the heavy elements are robably formed in the stellar processes in very high ates of excitation favourable for spontaneous fission nd subsequent neutron evaporations from the ssion fragments which can lead only to lower isotopes f medium heavy elements. This seems to offer at ast a qualitative explanation of the absence of heavy otopes of Np and Pu in nature, the lower isotopes f which are, as already shown, highly unstable against dioactive decay. The same reason makes it possible iat the nuclear reactions which lead to the formation f $(4n + 1)$ nuclei in the laboratory cannot take place the stellar processes on account of serious com- etition from spontaneous fission processes of the ighly excited heavy nuclei formed in these processes.

A.

539.163

002. The disintegration of As^{73}. S. JOHANSSON. *rk. Fys.*, **4**, 273–85 (*Paper* 11, 1952).

As^{73} decays by *K*-capture and the resulting Ge^{73} mits two strongly-converted γ-rays, of 13·5 keV $K/M = 5{\cdot}4$) and 53·9 keV ($K/L + M = 5{\cdot}6$.) The 3·9 keV γ-ray seems to be magnetic quadrupole diation and the 13·5 keV γ-ray electric quadrupole. very weak γ-ray of about 81 keV has also been ound. The first excited level in Ge^{73} (53·9 keV) is etastable, and the second level is probably meta- able also. A level scheme is proposed for Ga^{73}, e^{73} and As^{73}.

A.

539.163

003. The isomers of krypton and xenon: an investi- ation with electromagnetically separated radioactive otopes. I. BERGSTRÖM. *Ark. Fys.*, **5**, 191–295 *Paper* 14, 1952).

The following radioactive isotopes have been vestigated: Kr^{79}, Kr^{83m}, Kr^{85}, Kr^{85m}, Xe^{125}, I^{125}, e^{127}, Xe^{129m}, Xe^{131m}, Xe^{133}, Xe^{133m} and Xe^{135}, using, r the β-spectrometer and scintillation spectrometer vestigations, electromagnetically separated radio- tive Kr and Xe. Two new isomers of Xe^{129m} and e^{133m} were discovered, and the isomerism of Xr^{131m} tablished. Kr^{83m} proved to decay with the emission two γ-rays of quite other energies than those rlier accepted. A consistent decay scheme of Kr^{85m} is been constructed. In almost all other cases no spectrometer investigations have been performed rlier because of the great difficulties in preparing is samples convenient for β-spectrometer measure- ents. Because of the ideal character of the separated mples it was possible to detect and study very low- ergy electron lines. Several low-energy γ-rays not rlier known have thus been discovered. The pearance of the low-energy Auger lines is used to aw conclusions about the radioactive decay of the otopes investigated. The experimental results are mpared with the predictions of the *j–j* nuclear shell eory. In the majority of the cases investigated a od agreement with the theoretical predictions is tained.

A.

539.163.2

6004. On the question of the existence of a short-lived A^{39}. W. HÄLG. *Helv. Phys. Acta*, **24**, 641–3 (*No.* 6, 1951) *In German.*

Potassium was irradiated with fast neutrons and the resultant activities examined; no evidence for a short-lived A^{39} isotope was found. A. O. STANESBY

539.163.2

6005. The series of successive radioactive transitions $Zr^{95} \rightarrow Nb^{95} \rightarrow Mo^{95}$. V. S. SHPINEL. *Zh. Eksper. Teor. Fiz.*, **21**, 1370–5 (*No.* 12, 1951) *In Russian.*

These were investigated by means of a β-spectrometer with a thin magnetic lens. The β^--spectrum of Zr^{95} is complex, consisting of one component with max. energy 365 ± 10 keV and intensity 95% and two weak components with max. energies ~ 600 and 1100 keV. The β^--spectrum of Nb^{95} is simple with max. energy 148 ± 5 keV. Traces of conversion "peaks" associated with the 240 keV isomeric transition of Nb^{95*} were observed. For Zr^{95} and Nb^{95} γ-rays of almost equal energy of 730–750 keV were found. A possible decay scheme is constructed and the results are discussed in relation to the nuclear shell model. W. J. SWIATECKI

539.163.2

6006. An investigation of the radioactive emissions of Ir^{192}, Ag^{110} and In^{114}. V. S. SHPINEL AND N. V. FORAFONTOV. *Zh. Eksper. Teor. Fiz.*, **21**, 1376–83 (*No.* 12, 1951) *In Russian.*

An investigation of the spectrum of photoelectrons from Ir^{192} by means of a spectrometer with a transverse, non-uniform, axially symmetric magnetic field. The deduced complex γ-spectrum agrees with the results of other authors obtained from conversion electrons, but the intensities disagree with the scheme proposed by Cork, Shreffler and Fowler [Abstr. 1049 (1948)]. The β- and conversion spectra of Ag^{110} and In^{114} were investigated. In In^{114} γ-rays of 553 and 711 keV were found in agreement with Boehm and Preiswerk (1949). W. J. SWIATECKI

539.163.2

6007. Coincidence studies on the decay schemes of ^{131}I, ^{124}Sb and ^{110}Ag by means of scintillation spectrometers. S. A. E. JOHANSSON AND S. ALMQUIST. *Ark. Fys.*, **5**, 427–51 (*Paper* 20, 1952).

β–γ and γ–γ coincidence measurements (resolving time 2 μsec) were made using NaI(Tl) phosphors with a single-channel pulse amplitude analyser in one channel, and a pulse amplitude spectrograph with photographic recording in the other. The spectra and decay shemes of I^{131}, Sb^{124} and Ag^{110} are discussed. Weak sources of ~1 μC were used.

A. O. STANESBY

539.163.2

6008. Radiations from Ne^{19} and Na^{21}. G. SHRANK AND J. R. RICHARDSON. Letter in *Phys. Rev.*, **86**, 248 (*April* 15, 1952).

The short-lived positron emitters Ne^{19} and Na^{21}, obtained by proton bombardment of F^{19} and Mg^{24} resp., were examined with a 180° β-spectrometer and a NaI crystal γ-ray spectrometer; the ½-lives obtained were 18·5 ± 0·5 and 22·8 ± 0·5 sec, and E_{max} 2·18 ± 0·03 and 2·50 ± 0·03 MeV resp. (both Kurie plots allowed). The γ-ray spectrometer showed no lines above 0·51 MeV. A. O. STANESBY

539.163.2

6009. The radiation characteristics of Cm^{240} and Cm^{241}. G. H. HIGGINS AND K. STREET, JR. Letter in *Phys. Rev.*, **86**, 252–3 (*April* 15, 1952).

Samples of Pu^{239} were bombarded with He ions of 25–40 MeV energy and the Cm fractions examined for α-particles, and conversion and Auger electrons, after separation and purification by ion exchange techniques. An α-activity of ½-life 27 days (6·25 MeV) was assigned to Cm^{240}, and a 35-day activity ($E_\alpha = 5{\cdot}89$ MeV, capture/α ratio = 360–460) to Cm^{241}. A. O. STANESBY

539.163.2

6010. Radioactivity in neutron activated platinum. J. M. CORK, J. M. LEBLANC, F. B. STUMPF AND W. H. NESTER. Letter in *Phys. Rev.*, **86**, 415–16 (*May* 1, 1952).

Further expts. [see also Abstr. 6072 (1950)] indicated that the 4·4-day activity is probably due to an isomeric state of Pt^{195}; further lines were found in the electron spectrum of irradiated Pt and of Au separated from it chemically. Level schemes for the residual nuclei Pt^{195}, Au^{197} and Hg^{199} are suggested. A. O. STANESBY

539.163.2

6011. The decay of rubidium 87. M. H. MACGREGOR AND M. L. WIEDENBECK. Letter in *Phys. Rev.*, **86**, 420–1 (*May* 1, 1952).

The disintegration rate of Rb^{87} was measured using a cell counter [Abstr. 8934 (1950)] as 478 disintegrations/g RbCl/sec, giving a ½-life of $6{\cdot}23 \pm 0{\cdot}3 \times 10^{10}$ yr. Coincidence measurements indicated that the β-decay is simple. A. O. STANESBY

539.163.2

6012. The disintegration scheme of K^{40}. M. PAGANELLI AND G. QUARENI. Letter in *Phys. Rev.*, **86**, 423–4 (*May* 1, 1952).

Coincidence experiments using shielded G.M. counters containing thin layers of K salts suggest that the γ-radiation and *K*-capture of K^{40} are associated. A. O. STANESBY

539.163.2

6013. The emission of *L* X-rays of lead in Po^{210} decay. W. RUBINSON AND W. BERNSTEIN. *Phys. Rev.*, **86**, 545–51 (*May* 15, 1952).

By use of a proportional counter X-ray spectrometer, it is established that Po^{210} sources emit characteristic *L* photons of Pb, in yield $2{\cdot}93 \times 10^{-4}(\pm 15\%)$ per α-particle. The excitation of these photons is ascribed to the ejection of *L* electrons from the electronic cortege of the nucleus in the act of α-decay, in a manner treated by Migdal's theory. The probability of *L* electron ejection is about $8{\cdot}8 \times 10^{-4}$ per α-particle, as computed from the observed photon yield and Kinsey's fluorescence yields. The theory in its present state accounts for only 13% of the photons observed. A.

539.164

6014. The α-activities of the two "long-lived" states of $^{211}_{84}Po$. N. FEATHER. Letter in *Phil. Mag.*, **43**, 476–8 (*April*, 1952).

The ½-lives of Po^{211} (25 sec) and Po^{211*} (0·52 sec) are discussed on the basis of a "difficulty factor" in the formation of the α-particle [Abstr. 6388 (1951)]. As in Bi^{210} (RaE), the difficulty factor is greater fo the state of lower spin (here Po^{211*}). A. O. STANESB

539.16

6015. Alpha-particles from the $Li^7 + T$ reaction J. T. DEWAN, T. P. PEPPER, K. W. ALLEN AND I ALMQVIST. Letter in *Phys. Rev.*, **86**, 416 (*May* 1, 1952)

A $Li_2^7SO_4$ target was bombarded with 240 ke tritons and the charged particles emitted at 90° we observed with a magnetic analyser and a proportion counter. α's of 5·95 MeV from $Li^7 + T \rightarrow He^6 + He^4 + 9{\cdot}79$ MeV and 4·91 MeV from $Li^7 + T \rightarrow He^4 + He^4 + n + n + 8{\cdot}85$ MeV were found. Th $He^6 - Li^6$ mass difference is computed as 3·55 0·03 MeV. F. R. HOD

539.1

6016. Tables of β-decay. II. The influence of t Coulomb field on β-spectra. B. S. DZHELEPOV AN L. N. ZYRYANOVA. *Zh. Eksper. Teor. Fiz.*, **21**, 923– (*No.* 8, 1951) *In Russian.*

For Pt I, see Abstr. 4301 (1950). Two simil tables, respectively for β^- and β^+ emitters, give t Fermi function $F(E, Z)$, for allowed transitions, 4 figures for $Z = 0(5)100$ for about 100 end-poi energies between 1 and 10^4 keV, appropriate atom weights being assumed for each *Z* and mode of deca Data are given for conversion to other atomic weigh The function *F* was calculated from a compl Γ function, which was computed from a generalizati of Stirling's formula; the method of computation discussed but tables of the Γ function are not give J. C. E. JENNIN

539.1

6017. Investigation of the radiation from $Eu^{152,}$ using a twin [lens] β-spectrometer. L. YA. SHA TVALOV. *Zh. Eksper. Teor. Fiz.*, **21**, 1123–6 (*No.* 1951) *In Russian.*

The instrument was that used in Abstr. 3356 (195 The 9·2 hr activity of Eu^{152} was inappreciable un the conditions of the experiment, only the 5·3 a 5·4 yr activities of Eu^{152} and Eu^{154} respectiv remaining. Coincidences were measured betwe certain conversion lines and the continuous spectrum. The complex continuous spectrum found to include a component with upper lim 0·75 MeV, which is attributed to Eu^{152}. The 122 k γ-line is attributed to the *K*-capture branch of Eu Results are consistent with Hayden, Reynolds a Inghram, Abstr. 4987 (1949) and Abstr. 5243 (195 J. C. E. JENNIN

539.1

6018. Self-scattering and self-absorption of betas moderately thick samples. W. E. NERVIK AND P. STEVENSON. *Nucleonics*, **10**, 18–22 (*March*, 1952).

Experiments investigating the effect of self-scatt ing and self-absorption of β-particles of wid varying energy (E_{max} from 0·167 MeV to 2·2 MeV two materials containing light and heavy eleme [NaCl and $Pb(NO_3)_2$] are described. The β-act isotope, in solution with the inert salt in kno concentration, was drawn as a fine mist into a heat chamber (130°c). The water evaporated leavin residue of dust particles which were deposited on t stainless steel filter. Uniform layers of the scatteri absorbing salt containing the active isotope w

btained. Measurements were made in steps of mg/cm² in thickness of deposit up to 20 mg/cm², sing an end-window G.M. counter. Curves are iven showing the appropriate correction factor for cattering and absorption as a function of sample hickness for various β-energy end points (0·15 to MeV) in both NaCl and $Pb(NO_3)_2$. L. R. SHEPHERD

539.165

019. Research on the β-spectrum of Ra*D* by the ıethod of β-particle/conversion-electron coincidences. . TEILLAC, P. FALK-VAIRANT AND C. VICTOR. *J. Phys. Radium*, **13**, 143–7 (*March*, 1952) *In French.*

Absorption measurements on the radiation co-ıcident with the conversion electrons of the 47 keV -ray of RaE showed that it probably consists of Auger electrons. No trace was found of the ontinuous β-spectrum, of which ⩾90% lies below keV. A. O. STANESBY

539.165

020. The re-investigation of some photoelectron ines of thorium (B + C). D. A. SILVERSTON. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 344–9 (*May*, 1952).

The β-ray spectrum of thorium (B + C) has been e-investigated using the β-ray spectrograph described ı Abstr. 5834 (1952). The range 200 keV–300 keV vas studied in detail using photographic recording nd a previously unobserved γ-ray of energy 94·6 keV has been attributed to the transition horium C.C″. The conversion lines of the γ*F*-ray of horium B.C in the L_I, L_{II} electronic shells have been esolved and their relative intensities have been found sing a Geiger counter. The conversion of the same -ray in the M_I, M_{II} electron shells has been measured nd the lines have been partially resolved. The *M* hotoelectron line associated with the transition horium C″.D has been examined, and its suspected oublet structure confirmed. A.

539.165

021. A re-investigation of the double beta-decay rom Sn^{124}. E. L. FIREMAN AND D. SCHWARZER. *Phys. Rev.*, **86**, 451–3 (*May* 15, 1952).

Radiations from natural Sn and Sn enriched with ıe 124 isotope were examined in a magnetic field vith a He-filled cloud chamber triggered by internal ounters. Only 3 pictures out of more than 4000 hotographs are pictures of 2 electrons coming out of ıe same point in the Sn and entering the counters, nd even these may be pictures of multiply scattered lectrons passing through the Sn. However, one may et a lower limit to the half-life of double β-decay rom Sn^{124} as 10^{17} years. This is a decay rate less than $\frac{1}{10}$ of a value previously reported by one of the uthors. A.

539.165 : 539.166

022. β–γ polarization correlation in Sb^{124}. R. TUMP. Letter in *Phys. Rev.*, **86**, 249 (*April* 15, 1952).

β–γ polarization correlation depends only on the bserved (β–γ) angular correlation and the parity hange of the γ-transition. Measurement of the orrelation coefficient in the case of Sb^{124} (2·29 MeV -particle, 0·60 MeV γ-ray) showed that there is no hange of parity in the γ-transition, in agreement ith the decay scheme of Stevenson and Deutsch Abstr. 8937 (1951)]. A. O. STANESBY

539.165.2

6023. The interpretation of image transitions in beta-decay theory. G. L. TRIGG. *Phys. Rev.*, **86**, 506–12 (*May* 15, 1952).

The allowed favoured β-transitions are studied in relation to problems of nuclear structure and β-decay theory. These problems include (1) the influence of deviations from *L-S* coupling on the β-decay matrix elements of the light nuclei, (2) the relation between the observed magnetic moments, simple nuclear models and deviations from *L-S* coupling, (3) determination of the ratio of Fermi to Gamow–Teller type coupling constants, and (4) determination of the absolute magnitudes of the coupling constants. The analysis of all available data yields two mutually supporting conclusions: (*a*) a substantial Fermi-type component is present in the β-decay interaction, and (*b*) deviations from *L-S* coupling are an important factor in the interpretation of nuclear magnetic moments. A.

539.165.2

6024. The Sargent diagram for the electron-capture process, and the disintegration energies of heavy β-emitters. N. FEATHER. *Proc. Roy. Soc. Edinb. A*, **63**, 242–56 (*Pt III*, 1952).

A Sargent diagram is presented containing 12 plotted points relative to capture-active species in the range of atomic number (Z) from 89 to 98 inclusive. Arguments are adduced to show that the "allowed" line of the diagram is located as theory predicts, and the capture transformations of other heavy capture-active species are discussed with the aid of the diagram. In particular, values are deduced for the energies of capture transformation of 17 species for which $79 \leqslant Z \leqslant 85$, and, taking count of these values, the energies of β-disintegration of 150 species having $76 \leqslant Z \leqslant 98$ are assumed known, and are suitably plotted against neutron number N. Discontinuities are found, for certain values of isotopic number, in the region of $N = 126$ (and $Z = 82$). Values of α-disintegration energy are also deduced for certain isotopes of Bi and Pb. A.

539.165.8

6025. Neutrino recoils following the capture of orbital electrons in A^{37}. G. W. RODEBACK AND J. S. ALLEN. *Phys. Rev.*, **86**, 446–50 (*May* 15, 1952).

The energy spectrum of the recoil nuclei resulting from orbital electron capture in A^{37} has been determined by a time-of-flight measurement of the recoil ions. A^{37} disintegrations occurred within a gas-filled source volume, where the total pressure was approximately 10^{-5} mm of Hg. The time-of-flight distribution, as measured by a multichannel delayed-coincidence technique, has a definite maximum time limit. Furthermore, the shape and extent of the distribution correspond to that expected from mono-energetic recoils, originating in an extended source and having an energy of 9·7 eV as predicted by the single neutrino hypothesis. Zero and short-time coincidences were observed in addition to the above distribution. Further measurements indicate these to be the result of electron scattering associated with A^{37} decays not originating in the source volume. A.

539.166

6026. Investigation of γ-spectra with the scintillation spectrograph. D. MAEDER AND P. PREISWERK. *Helv. Phys. Acta*, **24**, 625–7 (*No.* 6, 1951) *In German.*

The 5·1 min Cu^{66} γ-line was measured as (1·045 ± 0·010) MeV, and γ-lines from Rh^{104} as (0·56 ± 0·01) and (1·1 ± 0·1) MeV. The spectrograph was also used to measure the maximum energy of γ-rays from Fe^{55}. F. R. HOLT

539.166

6027. Gamma radiation of Ag^{110}. B. S. DZHELEPOV, N. N. ZHUKOVSKIĬ AND YU. V. KHOLNOV. *Guide Russ. Period. Lit. Brookhaven*, **4**, 369–70 (*Dec.*, 1951).

Full translation of article abstracted in Abstr. 9671 (1951).

539.166

6028. On the measurement of the angular correlation between two gamma rays of nickel (60). S. DAS AND S. K. SEN. *Indian J. Phys.*, **25**, 451–7 (*Sept.*, 1951).

The angular correlation between the two cascade γ-rays of $Co^{60} \rightarrow Ni^{60}$ transitions has been measured, using Geiger–Müller counters. The source was in the form of $CoCl_2$ solution. From the correlation function $W(\theta)$ of Hamilton, the curve $N(\theta)/N(\pi/2)$ plotted against θ is explained on the assumption that the two radiations are octupole–octupole in nature. An alternative spin-parity scheme of $Co^{60} \rightarrow Ni^{60}$ transitions has been suggested. A.

539.166

6029. Gamma-gamma angular correlation in Pd^{106}. G. B. ARFKEN, E. D. KLEMA AND F. K. MCGOWAN. Letter in *Phys. Rev.*, **86**, 413–14 (*May* 1, 1952).

With a Ru source, the angular correlation of the 513 and 624 keV γ-rays of Pd^{106} was re-investigated, using NaI scintillation spectrometers with a resolution of ~10%. The angular variation is close to the theoretical curve [Abstr. 7475 (1950)] but the ratio W(180°)/W(90°) is 1·91 ± 0·04 compared with the theoretical value of 2. A. O. STANESBY

539.166

6030. Spin and parity of the first (603 keV) excited state of Te^{124}. F. R. METZGER. Letter in *Phys. Rev.*, **86**, 435 (*May* 1, 1952).

The *K*-conversion coeff. (α_K) of the 603 keV γ-ray of Te^{124m} (1st excited state) was measured directly from the *K*-conversion and *K*-photoelectron lines of two standardized sources, as $\alpha_K = (4 \cdot 25 \pm 0 \cdot 3) \times 10^{-3}$, and the γ-ray shown to be electric quadrupole; the spin of the 1st excited state of Te^{124} is then 2, parity even. A. O. STANESBY

539.166

6031. Intensity distribution of bremsstrahlung from beta-rays. S. J. WYARD. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 377–9 (*May*, 1952).

The intensity distribution of the external bremsstrahlung emitted in the slowing down of the electrons emitted in the β-decay of P^{32} is calculated. The absorption curve for this radiation has been measured in lead, in good agreement with expectation based on the photon distribution calculated. R. H. DALITZ

539.166

6032. The gamma-radiations from V^{48} and Nb^{92}. H. K. TICHO, D. GREEN AND J. R. RICHARDSON. Letter in *Phys. Rev.*, **86**, 422 (*May* 1, 1952).

For V^{48}, a NaI Hofstadter-type spectrometer was used. A new line at 2·22 ± 0·02 MeV was found, the number of quanta being 3·6% of the 1·32 MeV line. 2·31 MeV cross-over γ's were less than 0·5% of the 1·32 MeV quanta. Proton bombardment of Nb^{93} gave 2 lines. The weaker, 1·84 MeV, is attributed to 42 day Nb^{93*}. The other (0·93 MeV) is from Nb^{92}. F. R. HOLT

539.166

6033. 498-keV gamma-ray of Ru^{103}. A. W. KNUDSEN. Letter in *Phys. Rev.*, **86**, 571 (*May* 15, 1952).

Energy measurement gave 497·9 ± 0·8 keV.

J. J. WILKINS

539.166

6034. Angular correlation of first and third gamma rays. G. B. ARFKEN, L. C. BIEDENHARN AND M. E. ROSE. *Phys. Rev.*, **86**, 761–3 (*June* 1, 1952).

In a nuclear cascade involving three or more γ-rays it is both desirable and feasible to measure the angular correlation of non-consecutive γ's either to confirm the results of correlating consecutive radiations or to resolve possible ambiguities. The angular correlation functions for the observation of the 1st and 3rd γ's in a triple cascade have been calculated with the use of Racah functions for cases of physical interest. While the anisotropies tend to be somewhat less than those from the correlation of consecutive γ-rays, they are easily detectable by present experimental techniques. A

539.16

6035. Gamma-rays associated with selected neutron induced radioactivities. W. C. RUTLEDGE, J. M. CORK AND S. B. BURSON. *Phys. Rev.*, **86**, 775–86 (*June* 1952).

By means of photographic magnetic spectrometer located close to the heavy-water moderated reactor the following radioactive nuclei have been examined: Se^{77m} (17·5 sec), Se^{79m} (3·5 min), Se^{81m} (58 min), Se^{81} (17 min), Se^{83} (69 sec), Se^{83} (26 min), Nd^{1} (11·9 days), Nd^{149} (1·8 hr), Nd^{151} (12 min), Pm^{1} (50 hr), Pm^{151} (27·5 hr), Sm^{145} (410 days), Sm^{1} (> 20 yr), Sm^{153} (46·5 hr), Sm^{155} (23·5 min), Eu^{1} (1·7 yr), Mo^{101} (14 min), Tc^{101} (15 min) and Th^{2} (23·6 min). The 27·5-hour activity assigned to Pm^{1} was discovered in this work. A new vacuum gate for the camera of the spectrometer permits the study of activities with half-lives as short as 10 sec. Energy level schemes for the product nuclei are proposed on the basis of a spectrographic analysis of the γ-rays and also of coincidence and absorption measurements. Changes in spin and parity between many of the energy levels are determined from measurements of the *K*/*L* ratios of the corresponding γ-rays.

539.166 : 537.56

Gamma-ray half-lives and beta-gamma coincidences of $Hg^{198, 199}$, Xe^{131} and ThC. *See Abstr.* 5856

539.166 : 539.172.4

6036. Gamma-ray spectra of the Los Alamos reactors. J. W. MOTZ. *Phys. Rev.*, **86**, 753–4 (*June* 1, 1952).

The γ-rays emitted from a U^{235} slug at the centre of the Los Alamos water boiler and from the core of the "fast reactor" were analysed with a magnetic Compton spectrometer during the period that each reactor operated at a constant power level (30 kW for the water boiler and 25 kW for the fast reactor). An absolute γ-ray spectrum (neglecting line structure) was determined for each reactor in an energy range from about 0·5 MeV to 12 MeV. In both cases, the number of photons emitted per unit energy interval decreased exponentially with photon energies so that the value at 8 MeV was less by a factor of 10^4 than the value at 0·5 MeV. The average quantum energy for this type of spectrum was approximately 1 MeV. The total energy release of γ-radiation from the U^{235} slug (dia. 2·22 cm, length 0·426 cm, weight 28·5 g, 95% purity) occurred at a rate of about 2×10^{13} MeV/sec. A.

539.166.83

6037. Determination of Auger coefficients with the help of spectrometric coincidence measurements. O. HUBER, F. HUMBEL, H. SCHNEIDER AND A. DE SHALIT. *Helv. Phys. Acta*, **24**, 627–8 (*No.* 6, 1951) *In German.*

Apparatus described earlier [Abstr. 5698 (1951)] was used to find the Auger coefficients from coincidence rates for *KXY*-transitions in silver. Results agreed well with the theoretical values of Pincherle (1935) and Massey and Burhop (1936). F. R. HOLT

539.166.83

6038. The width of γ-lines and the Doppler broadening of conversion electron lines. V. S. SHPINEL AND R. I. MOSHKINA. *Zh. Eksper. Teor. Fiz.*, **21**, 1127–31 (*No.* 10, 1951) *In Russian.*

The G_A line arising from the conversion of the 287 keV γ-line of ThC″ was examined in the spectrograph described in Abstr. 1867 (1951). The source was deposited on a 50 μ Pt wire. Observed $\frac{1}{2}$-width $\Delta H\rho/H\rho \simeq 0{\cdot}18\%$ showed no Doppler broadening (compared with neighbouring lines) from recoil of atoms due to preceding α-emission. It is concluded that lifetime of excited state $>10^{-13}$ sec. Considering broadening of effective source due to recoil atoms leaving the wire and then emitting a conversion electron, it is further concluded that the lifetime $<10^{-10}$ sec. The lifetime calculated from the internal conversion coefficient, assuming electric quadrupole radiation, is $\sim 10^{-10}$ sec. J. C. E. JENNINGS

539.166.83

6039. The electron spectra produced by a Co^{60} source in water. E. HAYWARD. *Phys. Rev.*, **86**, 493–5 (*May* 15, 1952).

The spectra of secondary electrons produced by a Co^{60} γ-ray source have been measured at distances of 10, 20, 41·6, 81·6, 121·6 and 161·6 cm in a large tank of water. The pulse-height distribution representing the energy lost in an anthracene crystal was determined for each separation of detector and source. The shape of the spectrum was found to change appreciably with distance. The results agree remarkably well with theoretical predictions. A.

539.166.83

6040. Internal conversion of the 0·411-MeV gamma-ray of Hg^{198}. L. SIMONS. Letter in *Phys. Rev.*, **86**, 570 (*May* 15, 1952).

Measurements gave $\alpha_K = 0{\cdot}0307$, which agrees well with the theoretical 0·031 for electric quadrupole radiation. J. J. WILKINS

539.166.83 : 537.533.72

Note on the reported fine-structure of certain internal conversion lines of RaC . C′. *See Abstr.* 5834

539.166.835

6041. Determination of multipole orders from internal pair formation. H. SLÄTIS AND K. SIEGBAHN. *Ark. Fys.*, **4**, 485–94 (*Paper* 32, 1952).

A survey of various methods of measuring multipole orders of transitions and a description of earlier measurements of positrons originating in pair creation are given. Using a high transmission β-spectrometer the internal pair formation for γ-rays emitted in the decay of ThC″, Na^{24}, Mn^{56} and Co^{60} was investigated and compared with the theory of Jaeger and Hulme (1935). W. J. SWIATECKI

539.166.835

6042. A γ-ray detector employing multiple scattering separation of electron pairs. R. H. HILDEBRAND, N. KNABLE AND C. E. LEITH. Note in *Rev. Sci. Instrum.*, **23**, 243 (*May*, 1952).

539.167.3

6043. Rapid separations of protactinium and uranium radioisotopes from cyclotron bombarded thorium nitrate. W. W. MEINKE. Letter in *J. Chem. Phys.*, **20**, 754 (*April*, 1952).

Describes two new techniques (bombarding Th as $Th(NO_3)_4$ in the jiffy-probe of the Berkeley 184-in cyclotron with a pneumatic tube which delivers the target to the processing area within 12–15 sec after the end of bombardment, and using wet coarse filter paper as a separating medium in the extraction process) enabling the separation time to be reduced to *c.* 1 min. F. LACHMAN

NUCLEAR REACTIONS 539.17

539.172 : 530.145

6044. The collision matrix for the compound nucleus. T. D. NEWTON. *Canad. J. Phys.*, **30**, 53–69 (*Jan.*, 1952).

The nuclear collision matrix is calculated under the restrictions of the compound nucleus hypothesis. The matrix so found contains only one undetermined function, $\tau(E)$, a phase shift caused by nuclear interaction. Cross-sections are evaluated in terms of $\tau(E)$, a set of constants and functions determined by the non-nuclear potentials. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 5880, 5888

539.172.13

6045. The energy and angular distribution of the lithium γ-radiation. H. Nabholz, P. Stoll and H. Wäffler. *Helv. Phys. Acta*, **25**, 153–84 (*No.* 1–2, 1952) *In German.*

The spectrum of the γ-radiation from the reaction $Li^7(p, \gamma)Be^8$ was examined, using the photodisintegration process $C^{12}(\gamma, \alpha)2\alpha$ in nuclear emulsions for detection; there are indications of a weak line of $\sim 12{\cdot}5$ MeV in addition to the known 14·7 and 17·6 MeV lines. For resonance protons of 440 keV, the angular distribution of the 2 higher-energy γ-rays was isotropic within 20%. With incident protons of 550 keV energy, the ang. dist. of the total γ-emission was obtained using G–M counters in coincidence; it was strongly anisotropic. A. O. STANESBY

539.172.13

6046. The disintegration of N^{15} by protons. A. Schardt, W. A. Fowler and C. C. Lauritsen. *Phys. Rev.*, **86**, 527–35 (*May* 15, 1952).

The absolute cross-sections of the reactions (1) $N^{15}(p, \alpha)C^{12}$, (2) $N^{15}(p, \alpha\gamma)C^{12}$ and (3) $N^{15}(p, \gamma)O^{16}$ have been measured from 0·2 to 1·6 MeV. The thick target yield of reaction (1) was also measured at 0·100 MeV. Resonances were found at 0·338, 1·05 and 1·210 MeV for reaction (1); at 0·429, 0·898, 1·210 and possibly 1·05 MeV for reaction (2); and at 1·05 MeV for reaction (3). Most of the resonances follow closely the shape of the single level dispersion formula. The 1·05 MeV resonance is asymmetric and cannot be explained as easily. The cross-section of reaction (1) has been extrapolated to stellar energies and is given by $\sigma = (110/E) \times \exp(-6{\cdot}95E^{-\frac{1}{2}})$ barns for E in MeV in the energy region near 0·030 MeV. A.

539.172.13

6047. New energy level in ^{7}Li. A. Ashmore and J. F. Raffle. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 296–7 (*April*, 1952).

The reaction $Be^9(d, \alpha)Li^7$ was investigated using deuterons of 5·31 MeV and a thin Be target, and the new [Abstr. 5740 (1951)] excited state of Li^7 confirmed. The excitation energy was $4{\cdot}59 \pm 0{\cdot}10$ MeV. A. O. STANESBY

539.172.13

6048. Short-range protons from the deuteron bombardment of Li^6. R. W. Gelinas and S. S. Hanna. Letter in *Phys. Rev.*, **86**, 253–4 (*April* 15, 1952).

Short-range protons from the reaction $Li^6(d, p)Li^7$ were examined, using deuterons of energy $\sim$1 MeV and detecting the protons in nuclear plates in a magnetic spectrograph. The Q-value for the reaction is $0{\cdot}410 \pm 0{\cdot}015$ MeV and the excited state of Li^7 is at $4{\cdot}610 \pm 0{\cdot}020$ MeV. Evidence was also obtained for the occurrence of the reaction $Li^6(d, t)Li^5(p)He^4$. A. O. STANESBY

539.172.13

6049. Excited states of P^{32} from the $P^{31}(d, p)P^{32}$ reaction. D. M. Van Patter, P. M. Endt, A. Sperduto and W. W. Buechner. *Phys. Rev.*, **86**, 502–6 (*May* 15, 1952).

The $P^{31}(d, p)P^{32}$ reaction has been investigated by means of magnetic analysis of the protons emitted from thin targets containing phosphorus bombarded by 1·8 and 2·0 MeV deuterons. Sixteen of the proton groups observed have been assigned to the $P^{31}(d, p)P^{32}$ reaction, corresponding to the ground state and fifteen excited states of P^{32}, in a region of excitation from zero to 4·3 MeV. The position of the first excited state of P^{32} has been measured as $77{\cdot}0 \pm 1{\cdot}7$ keV. Three other pairs of closely spaced levels were observed. These occurred at 2·2, 2·7 and 3·3 MeV excitation with spacings of 50 ± 2, $92 \pm$ and 59 ± 3 keV, respectively. Because of the presence of contaminant groups, it is possible that some $P^{31}(d, p)P^{32}$ groups were missed, corresponding to states in a region of excitation from 3·3 to 4·3 MeV. The nucleus P^{32} appears to have a large number of low-lying states, with the first level very near to the ground state. A.

539.172.11

6050. Magnetic analysis of the $Mg^{25}(d, p)Mg^{26}$, $Mg^{26}(d, p)Mg^{27}$, and $Mg^{25}(d, \alpha)Na^{23}$ reactions. P. M. Endt, J. W. Haffner and D. M. Van Patter. *Phys. Rev.*, **86**, 518–22 (*May* 15, 1952).

Targets of magnesium oxide, enriched in Mg^{25} and Mg^{26} content, were bombarded by 1·8 MeV deuterons. Proton and α-particle groups observed at an angle of 90 degrees to the incident beam were studied with a high-resolution magnetic spectrograph. Eleven proton groups were assigned to the $Mg^{25}(d, p)Mg^{26}$ reaction; two proton groups were assigned to the $Mg^{26}(d, p)Mg^{27}$ reaction; and three α-particle groups were attributed to the $Mg^{25}(d, \alpha)Na^{23}$ reaction. The Q-values for the ground-state transitions are $8{\cdot}880 \pm 0{\cdot}010$, $4{\cdot}207 \pm 0{\cdot}006$ and $7{\cdot}019 \pm 0{\cdot}013$ MeV, respectively. The following level excitations were measured: Mg^{26}: 1·825, 2·972, 3·969, 4·353, 4·863, 4·924, 5·270, 5·322, 5·502 and 6·147 MeV; Mg^{27}: 0·987 MeV; Na^{23}: 0·43 and 2·07 MeV. A.

539.172.3

6051. The photo-disintegration of nitrogen-14 nuclei. D. L. Livesey and C. L. Smith. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 297–8 (*April*, 1952).

Observation of 5 stars attributed to the photo-disintegration $N^{14} \rightarrow H^1 + He^4 + Be^9$ is reported. J. J. WILKINS

539.172.3

6052. Cloud chamber identification of photodeuterons from copper. W. H. Smith and L. J. Laslett. *Phys. Rev.*, **86**, 523–4 (*May* 15, 1952).

The presence of a prominent group of photo-deuterons, produced by the irradiation of copper with 65 MeV bremsstrahlung, was demonstrated by experiments employing a 12-in cloud chamber traversed by a magnetic field. The mean curvature of each acceptable track studied was determined over a fixed range interval; the distribution of the curvatures so obtained provided a clear indication of proton and deuteron groups. Helium was used as the non-condensible component of the cloud chamber gas, in order to reduce the effect of scattering. The spread in curvature produced by scattering was determined, for protons, by a control experiment in which essentially only protons were present and the spread expected for deuterons under similar conditions was

...en readily estimated. The stopping power of the ...hamber gas was determined from the measured ...nge of polonium α-particles and permitted com...utation of the expected mean curvatures for the ...nscattered trajectories of protons and of deuterons. ...nalysis of the experimental composite distribution ...urve, representing the particles obtained in the ...hotodisintegration of copper, into proton and ...euteron components of the prescribed mean values ...nd widths, was then uniquely possible. The deuteron ...p proton ratio was thus found to be $0{\cdot}7_6$ for equal ...ange and solid angle intervals. It is estimated that ...he corresponding ratio for equal intervals of energy ...s approximately 0·5. A.

539.172.4

6053. Investigation of the reaction $B^{10}(n, \alpha)Li^7$ with neutrons of various energies. H. BICHSEL, W. HÄLG, ...P. HUBER AND A. STEBLER. *Helv. Phys. Acta*, **25**, 119–41 (*No.* 1–2, 1952) *In German.*

By determining the intensities of the two α-particle groups in a parallel plate ionization chamber filled with BF_3, the branching ratio of this reaction, for the transitions to the ground state and to the 478·5 keV excited state of the final Li^7 nucleus, was measured in the range 0–4 MeV. The ionization chamber was used to give the *Q*-value of this reaction and that of the reaction $D(d, n)He^3$, and good agreement with the accepted values was obtained. J. HUGHES

539.172.4

6054. Effective slow neutron capture cross-section of some elements. (Local modulation method.) J. AILLOUD, D. BRETON, A. ERTAUD AND V. RAIEVSKI. *J. Phys. Radium*, **13**, 171 (*March*, 1952) *In French.*

. Li, Co, Ge, Nd, Hg were measured by the method of Hoover *et al.* [Abstr. 2120 (1949)]. W. J. SWIATECKI

539.172.4

6055. The demonstration of the reaction $^{64}Zn(n, \alpha)^{61}Ni$ produced by slow neutrons. H. FARAGGI AND R. BERNAS. *C.R. Acad. Sci.* [*Paris*] **234**, 1684–6 (*April* 21, 1952) *In French.*

Using photographic emulsions it was shown that under the action of thermal neutrons the isotope Zn^{64} concentrated to 95% emits α-particles of ~6·6 MeV with a cross-section $\sim 1{\cdot}5 \times 10^{-29}$ cm². W. J. SWIATECKI

539.172.4

6056. Search for beryllium–7 in uranium fission. G. B. COOK. Letter in *Nature* [*Lond.*] **169**, 622 (*April* 12, 1952).

An attempt was made to observe the 0·48 MeV γ-ray of Be^7 after chemical extraction of Be from pile-irradiated uranium. 50 g of oxide, irradiated for 3 months, and 100 g of U metal, irradiated for 1 yr, were studied. In both cases the sample was dissolved as nitrate and 100 mg of Be added prior to the extraction. Failure to observe the Be^7 activity in the final Be samples led to the assignment of an upper limit of 10^{-5}% to the yield of ternary fissions with Be^7 emission. L. R. SHEPHERD

539.172.4

6057. Nuclear reactor catalog. H. S. ISBIN. *Nucleonics*, **10**, 10–16 (*March*, 1952).

A list of all reactors known to be operating at present or projected is given. The reactors are classified according to neutron energy, and appropriate details such as fuel, moderator, operating power, coolant, method of control and maximum neutron flux are set out where the data is available. L. R. SHEPHERD

539.172.4 : 518.5 : 621.317.79

6058. A portable electronic pile kinetic simulator. W. PAGELS. *Trans Amer. Inst. Elect. Engrs*, **70**, 1422–6 (*Pt II*, 1951).

The solution of the set of 7 pile kinetic equations which express the variation of neutron density as a function of time and reactivity is mathematically laborious. The instrument described comprises simple multiplying and delay networks (in which each unknown in the reactor equations is represented by voltage, each coefficient by a circuit constant and the complete terms by currents) together with a direct-coupled amplifier, the voltage across the (double-ended) output representing directly the number of thermal neutrons per cm³. A. J. KENNEDY

539.172.4 : 539.185

6059. Study of neutron density in the Chatillon pile. A. ERTAUD AND R. BEAUGÉ. *J. Phys. Radium*, **13**, 10A–13A (*Feb. Suppl.*, 1952) *In French.*

The distribution has been investigated with Mn activation detectors, which were standardized by means of a RaBe source in water. Curves are reproduced showing the distribution in neutron density across experimental channels, through the thermal columns and along the central tube through the core. The Laplacian of the pile was deduced from the last set of results, and found to be $5{\cdot}8\ m^{-2}$. The relationship between the maximum neutron density at the surface of the central fuel element and the pile power is derived. L. R. SHEPHERD

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

6060. On the interaction of mesons and plural *vs.* multiple meson production. A. W. STERN. *Science*, **115**, 352–3 (*March* 28, 1952).

The failure of conventional interaction models to account for the observed anomalous π-meson scattering above ~60 MeV and for *p–p* scattering at high energies is discussed and taken to suggest the operation of non-localizable, velocity-dependent forces of the many-body type. In view of this picture pure plural meson production is probably not valid and should perhaps be replaced by multiple production in one act by groups of nucleons acting as nuclear sub-units. W. J. SWIATECKI

539.18

6061. A search for new mesons by means of a cloud chamber. M. INOKI, T. YASAKI AND Y. MATSUKAWA. Letter in *Phys. Rev.*, **86**, 129–30 (*April* 1, 1952).

Of 27 particles stopped in a 2 mm C plate inside a cloud chamber at 300 m, and whose ionizations correspond to masses intermediate between the

electron and proton mass, only 2 produced decay electrons, indicating that the others cannot be μ mesons. W. J. SWIATECKI

539.18

6062. Deuterium total cross-sections for positive and negative pions. H. L. ANDERSON, E. FERMI, D. E. NAGLE AND G. B. YODH. Letter in *Phys. Rev.*, **86**, 413 (*May* 1, 1952).

This was deduced from the difference between H_2O and D_2O and the previously measured value for H, using the technique of Anderson *et al.* [Abstr. 4623–5 (1952)] for energies of 60–200 MeV. It was found that within the errors $\sigma_D(\pi^+) = \sigma_D(\pi^-) = \sigma_H(\pi^+) + \sigma_H(\pi^-)$. W. J. SWIATECKI

539.18

6063. Unusual π–μ decay in photographic emulsions. W. F. FRY. Letter in *Phys. Rev.*, **86**, 418 (*May* 1, 1952).

Eleven out of 10 686 observed π–μ decays had an unusually short μ track and of these 7 did not appear to be decays in flight of a backward moving π. The frequency and energy distribution of these events is in general agreement with recent theoretical explanations in terms of soft photon emission accompanying the charge acceleration of the μ at the moment of its creation. W. J. SWIATECKI

539.18

6064. Tests of charge independence from pion production in nuclear collisions. A. M. L. MESSIAH. Letter in *Phys. Rev.*, **86**, 430 (*May* 1, 1952).

If the total isotopic spin is a good quantum number in reactions involving nucleons and pions only it turns out that the cross-sections for the production of charged and neutral mesons in nuclear collisions must satisfy stringent relations. This is illustrated by examples, e.g. $\sigma(p + d \rightarrow H^3 + \pi^+) = 2\sigma(p + d \rightarrow He^3 + \pi^0)$ and $\sigma(n + p \rightarrow d + \pi^0) = \frac{1}{2}\sigma(p + p \rightarrow d + \pi^+)$. W. J. SWIATECKI

539.18

6065. Mean life of the positive π-meson. W. L. KRAUSHAAR. *Phys. Rev.*, **86**, 513–17 (*May* 15, 1952).

Photoproduced π^+ mesons stopped and decayed in a xylene-terphenyl liquid scintillation counter. The pulses from the counter were amplified and displayed on two oscilloscopes. The entire sequence $\pi^+ \rightarrow \mu^+ \rightarrow e^+$ could be observed, and from the measurement of 670 π–μ decay times, a value of $(2{\cdot}53 \pm 0{\cdot}10) \times 10^{-8}$ sec was obtained for the π^+ mean life. A.

539.18

6066. Some remarks on the *V*-particles. A. PAIS. *Phys. Rev.*, **86**, 663–72 (*June* 1, 1952).

It is qualitatively investigated whether the abundance of *V*-particle production can be reconciled with their long lifetime by using only interactions of a conventional structure. This is possible, provided a *V*-particle is produced together with another heavy unstable particle. Two distinct groups of interactions are needed: for one, the coupling is strong; for the other, it is very weak. Two kinds of *V*-particle are considered, Fermions of mass $\sim 2200m$ and Bosons ($\sim 800m$). The arguments are somewhat different, according to whether the latter are non-pseudoscalar or pseudoscalar. The competition with processes involving μ-mesons is discussed. Possible connections with the τ-meson are commented on. The preliminary nature of the present analysis is stressed. A.

539.18

6067. Study of the condensation of molecular jets by means of artificial radioactive isotopes. F. M. DEVIENNE. *J. Phys. Radium*, **13**, 53–8 (*Feb.*, 1952) *In French.*

The condensation of molecular jets of antimony and of gold was studied with metals which have been made radioactive in an atomic pile. A brief outline of earlier work on molecular jets is given, and the author's experimental arrangement is described. It is shown that condensation can take place when the flow density is extremely low. The nature of the condensing surface is an important factor. The condensed material was investigated by taking autoradiographs. J. IBALL

539.18

6068. The energy dependence of the effective cross-section in elastic scattering of neutrons by protons. T. SEXL AND H. ÜBERALL. *Z. Phys.*, **132**, 72–80 (*No.* 1, 1952) *In German.*

Formulae are derived enabling this to be calculated in a simple way and to an arbitrary approximation. W. J. SWIATECKI

539.18

6069. Scattering of neutrons by protons at high energies. D. BASU. *Indian J. Phys.*, **25**, 246–56 (*May*, 1951).

It is shown here that the recent experimental results on the neutron-proton scattering at 260 MeV energy favours the Möller–Rosenfeld interaction and rules out the pseudoscalar theory. Contrary to the general expectation that the Born approximation is valid before the influence of the radiation reactions needs to be taken into account, it is found that the Born approximation, which is reasonably valid for 260 MeV energy, gives a theoretical value twice as large as the experimental one, but the inclusion of the radiation damping term brings the theoretical value in good agreement with the experimental result. A.

539.18

6070. Low energy *n*–*d* scattering: comparison of experiment with theory. M. M. GORDON AND W. D. BARFIELD. *Phys. Rev.*, **86**, 679–84 (*June* 1, 1952).

D-wave effects are shown to be significant, though small, in the experimental *n*–*d* scattering data at 4·5 and 5·5 MeV. Consequently, since the calculations of Buckingham and Massey include only *S* and *P* wave phases, a phase shift analysis of the experimental data is carried out to determine these phases so that a suitable comparison can be effected between experiment and theory. The resulting "experimental" *P*-wave phases agree only qualitatively with those of

he symmetric-interaction calculations, but they completely disagree with those of the neutral-interaction alculations. The lack of quantitative agreement in he former case could be attributed to the range, epth and possibly shape of the inter-nucleon otential chosen by Buckingham and Massey, specially since their *S*-wave phases, which they ound to be insensitive to force-type, are not in atisfactory agreement with the experimental results f slow neutron scattering. A.

539.185

071. A phase shift analysis of neutron-deuteron cattering. A. L. LATTER AND R. LATTER. *Phys. Rev.*, **6**, 727–30 (*June* 1, 1952).

A simultaneous phase shift analysis of *n–d* and *p–d* ngular cross-sections is shown to be consistent with ne charge-independence hypothesis. Disagreement found with the theoretical phase shifts of Buckingam and Massey. A.

539.185

072. The production of neutrons by μ-meson apture in lead, magnesium, and calcium. A. M. ONFORTO AND R. D. SARD. *Phys. Rev.*, **86**, 465–75 *May* 15, 1952).

Measurements are reported of the yield of disntegration neutrons from the capture of stopped egative μ-mesons in Pb, Ca and Mg. A magnetized on lens is used to separate μ-meson capture from ther processes giving rise to neutrons associated ith telescope anticoincidences. The functioning of ne lens is tested experimentally by observation of ecay electrons from stopped mesons; as a byproduct, the competition between capture ($\tau_- = 1$ μsec or Mg) and natural decay ($\tau_0 = 2{\cdot}15$ μsec) is confirmed. The telescope coincidence and anticoincience rates are in excellent agreement with recent bsolute determinations of the μ-meson spectrum at a level. With Pb, there is a striking increase in the oherent neutron rate in switching from focusing ositive to focusing negative mesons. This confirms ne interpretation of earlier experiments without agnetic field as demonstrating neutron emission sulting from μ-meson capture. The average number f disintegration neutrons per capture appears to be ·47 ± 0·13 (statistical standard error), as compared ith the value 2·16 ± 0·15 (statistical standard ror) obtained by Crouch and Sard in an underound experiment. Systematic errors can account or the discrepancy; it is felt that somewhat more eight should be attached to the latter figure. With oth Mg and Ca, there is little, if any, neutron oduction in μ-meson capture. The neutron tecting efficiency is the same as for Pb, but the tio of neutrons detected to mesons captured is ·6 ± 0·5)% for Mg and for Ca, in contrast with ·1 ± 0·3)% for Pb. Despite the poor statistics of ese preliminary measurements, it is clear that the erage neutron multiplicity from Mg and Ca is nsiderably smaller than from Pb. A.

539.185

073. Polarization of D–D neutrons. H. J. NGLEY, R. N. LITTLE, JR, AND J. M. SLYE. Letter *Phys. Rev.*, **86**, 419 (*May* 1, 1952).

Using the method proposed by Schwinger [Abstr. 1669 (1948)], a polarization of ~30% was observed for neutrons emerging at 45° to the D beam.

W. J. SWIATECKI

539.185

6074. Regularities in the total cross sections for fast neutrons. H. H. BARSCHALL. Letter in *Phys. Rev.*, **86**, 431 (*May* 1, 1952).

Recently measured cross-sections are plotted in the range 0·1–3 MeV for $A \gtrsim 50$. V. F. Weisskopf has recently found that similar variations with energy may be obtained on the basis of a single-particle model. W. J. SWIATECKI

539.185

6075. The total neutron cross section of nitrogen. J. J. HINCHEY, P. H. STELSON AND W. M. PRESTON. *Phys. Rev.*, **86**, 483–92 (*May* 15, 1952).

The total cross-section of N has been measured for neutrons in the energy range 200 to 1800 keV, using scatterers of liquid N and of lithium azide. Eleven resonances were found, corresponding to excited states in the compound nucleus N^{15}, with natural widths of from 3 to 54 keV. Nine of these can be identified with resonances previously known in the reactions $N^{14}(n,p)C^{14}$, $N^{14}(n,\alpha)B^{11}$, or $C^{14}(p,n)N^{14}$. From a comparison of the measured and computed elastic scattering cross-sections, *J*-values can be assigned to most of the observed states. In some cases the parity also can be determined and the effective level spacing D_J computed for decay by neutron, proton, or α-particle emission. At least for proton emission, it must be concluded that the quantities D_J, which contain implicitly the matrix elements for the transition, can vary by a factor of at least 100. A.

539.185 : 539.172.4

Study of neutron density in the Chatillon pile. *See Abstr.* 6059

539.185 : 548.74

6076. Diffraction of slow neutrons by microcrystalline powders of UO_2 and CeO_2. F. VERDAGUER, C. SÁNCHEZ DEL RIO, R. KELLER AND A. KIND. *Helv. Phys. Acta*, **25**, 79–86 (*No.* 1–2, 1952) *In French.*

By transmission measurements through microcrystalline powders of UO_2 and CeO_2, using a moderated neutron source (moderator unspecified) and the velocity selector of the University of Geneva, curves were obtained relating total cross-section to wavelength. From these the scattering amplitudes of U and Ce are determined. J. THEWLIS

539.185.08

6077. Measurement of fast neutron flux. H. H. BARSCHALL, L. ROSEN, R. F. TASCHEK AND J. H. WILLIAMS. *Rev. Mod. Phys.*, **24**, 1–14 (*Jan.*, 1952).

This is reviewed under the following headings: associated particle methods; recoil particle methods; thermalization and radioactive product method; long counter and similar methods; method of reaction cross-section comparisons; flux measurements for polyenergetic neutrons. The accuracy of present methods has not been fully exploited and promising techniques are suggested and discussed. There are 69 references. W. J. SWIATECKI

STRUCTURE OF SOLIDS 539.2

539.21

6078. Consolidation phenomena in the alloy Cu_3Au. L. KHOLODENKO. *Zh. Eksper. Teor. Fiz.*, **20**, 1083–97 (*No.* 12, 1950) *In Russian.*

The influence of change of volume on the course of consolidation in the alloy Cu_3Au is first examined. By the aid of a large-scale model the dependence of the spectrum of oscillation of the crystalline lattice upon the state of consolidation of the crystal is demonstrated. The influence of this factor on the course of consolidation process is next investigated. Finally, experimental data relating to the dependence of compressibility, of the coefficient of volume enlargement and of the internal energy of the alloy upon temperature are compared and discussed. J. CLEUGH

539.215.4 : 535.43

6079. On the sizing analysis of fine particles by the photo-tube method. T. OHYAMA AND S. YASHIMA. *Techn. Rep. Tohoku Univ.*, **16**, 66–85 (*No.* 1, 1951).

Describes the construction of a scattered light sedimentometer for use in the sub-sieve range. It is shown that the dipole moment of the dispersing fluid effects the sedimentation velocity and the authors recommend the use of a non-polar fluid. Finally, the particle-size distribution of some powders used for the preparation of heavy media for ore separation by flotation is given. J. M. HOUGH

539.231

6080. Transparent conducting films on glass. *Nature* [*Lond.*] **169**, 829–30 (*May* 17, 1952).

A short description of a new process proposed for the preparation of such films, under study at the National Physical Laboratory.

539.234

6081. Use of a tungsten filament as support for the silvering of surfaces by vacuum evaporation. J. ROIG AND E. COLLET. *C.R. Acad. Sci.* [*Paris*] **234**, 1677–80 (*April* 21, 1952) *In French.*

The difficulties of adherence of the Ag to the supporting filament and of evaporation of the filament material are briefly discussed. A W filament, 0·5 mm dia., electrolytically treated as described by the author, was found to be successful; 90% of the Ag globules adhered to the surface of the filament. The process does not work for a Ta filament.

S. WEINTROUB

539.24 , 539.27

6082. A method for the electron and light optical microscopic examination of identical areas. E. D. HYAM AND J. NUTTING. *Brit. J. Appl. Phys.*, **3**, 173–6 (*June*, 1952).

The difficulties involved in attempting to obtain optical and electron micrographs from the same area of a metal surface using the standard dry-stripping technique are outlined. An attachment is described which fits over the objective lens of a bench metallurgical microscope, and enables replica supporting grids to be precisely positioned over a feature of interest in the microstructure. By this method, optical and electron micrographs of the same area of the surface may be readily obtained. The mode of operation is described in detail and the applications of the method are indicated. A

539.2

6083. A new type of interference fringe observed i electron-micrograph of crystalline substance. T MITSUISHI, H. NAGASAKI AND R. UYEDA. *Proc Japan Acad.*, **27**, 86–7 (*Feb.*, 1951).

Straight parallel fringes with spacings of abou 200 Å were observed on some micrographs of graphit crystallites. These may arise from interferenc between the main transmitted beam and a bea diffracted first by one crystallite and then by anothe with approximately the same orientation as th first. R. S. PEA

539.2

6084. Austenite in low carbon iron. J. W. MENTE J. NUTTING AND A. L. TSOU. Letter in *Proc. Phy Soc.* [*Lond.*] *B*, **65**, 305–6 (*April*, 1952).

Electron diffraction patterns indicate that gra boundary regions consist of a high-carbon-austeni of very small particle size, whereas the grains ther selves are ferrite. R. S. PEA

539.

6085. On the structure of copper films electr deposited on to an electrolytically polished sing crystal of β-brass. N. TAKAHASHI. *C.R. Acad. S* [*Paris*] **234**, 1619–21 (*April* 16, 1952) *In French.*

Electron diffraction patterns show that the fil are monocrystals whose orientation with respect t the β-brass axes is specific. Very thin films sometim show a hexagonal close-packed structure.

R. S. PE

ELASTICITY . STRENGTH . RHEOLO 539.3/.8

539.31 : 539.215.9 : 532.

6086. Stability of the elastic equilibrium of materi The case of bodies without cohesion and liqu A. KAMMERER. *C.R. Acad. Sci.* [*Paris*] **234**, 173 (*April* 28, 1952) *In French.*

Continuation of Abstr. 1370 (1951). By consid ing a liquid as a particular case of an elastic bo with Young's modulus = 0 and Poisson's ratio = an upper limit to the hydrostatic tension consist with stability is deduced. The corresponding criter for a powder (Young's modulus = 0, Poisson's r $\neq \frac{1}{2}$) is discussed. J. G. OLDR

539.

6087. On determination of the dynamic strengt metals. S. AINBINDER. *Latv. PSR Zin. Akad. V No.* 1, 137–48 (1951) *In Russian.*

The available experimental data can be qualitati evaluated only by considering the mechanics deformation on application of a dynamic l More accurate results can be obtained from the the of propagation of plastic deformation waves. S larity in tests can only be ensured by the equalit

e absolute impact velocities and of the ratios of the ıvelengths to the cross-sectional areas of the test ɔces. A. GELBTUCH

539.312

88. Apparatus for the measurement of the namic shear modulus and hysteresis of rubber at low equencies. W. P. FLETCHER AND A. N. GENT. *Sci. Instrum.*, **29**, 186–8 (*June*, 1952).

An apparatus is described which subjects a rubber st-piece to a force in simple shear, varying sinu-idally with time in the frequency range 0·0017–c/s; the instantaneous values of force and dis-acement being measured by photoelectric pick-ups. om the display on the screen of a cathode-ray tube the mechanical hysteresis loop described by the brating rubber, measurements are made which allow lculation of the dynamic shear modulus and ysteresis. Typical results are given. A.

539.32

89. On the theory of elastic properties of poly-ystals. I. M. LIFSHITS AND L. N. ROZENTSVEĬG. etter in *Zh. Eksper. Teor. Fiz.*, **21**, 1184 (*No.* 10, 51) *In Russian.*

Owing to an error in sign in formula 41 of the ıthors' paper [*ibid.*, **16**, 967 (1946)], expressions for e average "thermodynamic" and "macroscopic" oduli of elasticity were found to differ. Equations and 13 should be omitted; the rest of the paper is affected. A. GELBTUCH

539.32

90. Stress-strain relationship: a mathematical odel. E. J. WILLIAMS AND N. H. KLOOT. *Aust. J. pl. Sci.*, **3**, 1–13 (*March*, 1952).

A mathematical model has been devised for the ıdy of the properties of materials under load. It s been shown to yield load-deformation curves very nilar in general appearance to those obtained in actice with a variety of materials. The effect of rate straining indicated by the model is qualitatively nilar to that observed with wood. A.

539.32 : 537.228.1

Mechanical constants of barium titanate. *See Abstr.* 72

539.32 : 548.732

91. Determination of elastic constants of lithium ioride from photographs of diffuse reflexions of -rays. J. HOERNI AND W. A. WOOSTER. *Acta yst.*, **5**, 386–7 (*No.* 3, 1952).

A photographic method of determining elastic nstants from the study of diffuse X-ray reflections s been developed and applied to LiF. The results e as follows: $c_{11} = 9{\cdot}9\times10^{11}$, $c_{12} = 4{\cdot}3\times10^{11}$, $= 5{\cdot}4\times10^{11}$ dyne cm^{-2}. A.

539.373

92. Slip planes and the energy of dislocations. CHALMERS AND U. M. MARTIUS. *Proc. Roy. c. A*, **213**, 175–85 (*June* 24, 1952).

It is shown that the characteristic slip directions d planes in metal crystals can be explained and edicted by taking into account the dependence of the ergy of a dislocation on its plane. The energy of a slocation is considered as a function of the para-eter β, which is defined as the ratio of the Burgers vector to the interplanar spacing, and it is shown that the observed slip systems correspond to the lowest possible values of β in all the crystal types that have been studied. The reason for the existence of alternative slip systems, particularly at high temperatures, is also discussed in terms of this concept. A.

539.373 : 539.386

6093. Critical shear stresses in body-centered cubic lattices. R. SMOLUCHOWSKI. *Phys. Rev.*, **86**, 787–9 (*June* 1, 1952).

A consideration of the shape and of the atomic configuration of dislocations in a body-centred cubic lattice allows an estimate of the ratio of critical shear stresses on various slip planes as a function of temperature. A comparison with experimental data is satisfactory. A.

539.4.014 : 548.7

6094. On the meaning of the orientation-dependence of the strain-hardening curves for aluminium single crystals. P. HAASEN AND G. LEIBFRIED. *Z. Phys.*, **131**, 538–43 (*No.* 4, 1952) *In German.*

The strain-hardening curves are dependent on orientation for very pure (99·99%) aluminium. This fact is discussed in terms of the shearing stresses across various crystallographic planes of the stressed crystal, and the hindrance of slip on one plane by slip on others. A. R. STOKES

539.4.016 : 548.735.7

X-ray line broadening due to cold working. *See Abstr.* 6187–9

539.4.016.3

6095. Annealing conditions for bismuth. H. MEISSNER. *Z. angew. Phys.*, **4**, 59–60 (*No.* 2, 1952) *In German.*

Gives procedure for reducing the residual resistance of extruded wires. H. LONDON

539.434

6096. The flow of polycrystalline metals under simple shear. E. N. DA C. ANDRADE AND K. H. JOLLIFFE. *Proc. Roy. Soc. A*, **213**, 3–26 (*June* 5, 1952).

The creep of commercial Pb, pure Pb and Cd has been investigated under conditions of simple shear, by a method in which a constant couple is applied to an annulus cut in a thicker disk of the metal. For comparison, normal tensile tests have been carried out on wires of the same metals. It has been found that for all three metals the shear strain under simple shear stress varies as the cube root of the time, there being no permanent creep even at temperatures at which, in tensile tests at constant stress, the creep is predominantly linear with time. The effect of varying stress and temperature has been investigated. The pure Pb recrystallizes under conditions of strain which have been examined, the recrystallization being attended by accelerated flow. The method allows the creep under reversed stress to be examined. In reversal there is a contrast between Pb, which shows shear strain linear with time, and Cd, which shows a variation according to $t^{\frac{1}{3}}$, as with direct stress. This difference of behaviour is explained in terms of the glide properties of cubic as contrasted with hexagonal metal single crystals. The effect of a second reversal

of stress is consistent with this explanation. The cause of the elimination of permanent creep under the conditions of simple shear is discussed and a variety of experimental results explained in terms of intracrystalline and boundary effects, account being taken of the different crystal structure of Cd and Pb. A.

539.501

6097. The rheology of plastic dispersions. P. A. Briscoe, W. J. Dunning and R. C. Seymour. *Brit. J. Appl. Phys.*, **3**, 193–6 (*June*, 1952).

An account is given of the behaviour of a system containing 80% by volume of a powdered solid, which shows plastic deformation but does not conform to the Bingham or Freundlich concepts of plasticity. The term "dilatant plasticity" is suggested for such systems which have a small sedimentation volume, are dilatant, non-thixotropic and can be moulded but shear harden showing a series of yield values dependent on their previous history. Under a force exceeding one yield value, deformation does not proceed continuously but approaches a limiting value. The deformation properties of this system are characterized by two parameters. k measures the shear hardening due to changes in the geometry and structure of the powdered solid, and c expresses the relation between the limiting compression and the weight required to produce it. On roll milling, the parameters change in a reciprocal way, the product kc remaining approximately constant. A.

539.62

6098. A discussion on friction. *Proc. Roy. Soc. A*, **212**, 439–520 (*May* 22, 1952).

The discussion was held in April 1951, the papers (see abstracts following) being grouped under the headings: Friction of metals; Friction of non-metals; Boundary and extreme pressure lubrication.

539.62

6099. A discussion on friction: Introduction to the discussion: The mechanism of friction. F. P. Bowden. *Proc. Roy. Soc. A*, **212**, 440–9 (*May* 22, 1952).

The application of the electron microscope, and of metallurgical, interferometric and other physical methods, shows that even carefully polished or cleaved surfaces have irregularities on them which are large compared with molecular dimensions. When two solids are placed together, the real area of contact is very small, so that the local pressure is high and, in general, exceeds the yield pressure, p_m, of the metal. Plastic flow of the solid occurs at the summits of the irregularities so that the real area of contact A is proportional to the applied load W, i.e. $A = W/p_m$. There is adhesion at these local regions of contact and the friction is, in a large measure, the force required to shear them. As a rough approximation $F = As$, where s is the shear strength of the junctions. Since A is proportional to W and independent of the size of the surfaces, this can explain the classical laws of friction. The mechanism of this process has been studied by optical and metallurgical methods and by the use of artificially radioactive metals. The strength and nature of the adhesion between metals is profoundly influenced by the oxide films which are normally present on them. It is the presence of these films which enables sliding to occur. If these surface films are removed *in vacuo* and naked metals are placed in contact, there is strong adhesion—an attempt to slide them may cause further plastic deformation with consequent increase in the area of contact—and a large-scale "cold welding" of the metals. If the sliding speed is appreciable, the temperature at the local points of rubbing contact will be raised. These surface temperatures have been measured by a thermo-electric method, by a visual or photographic method and by the use of an infrared cell. All three methods give similar results and show that even at moderate speeds the local surface temperature may easily exceed 1000°C. It is limited by the melting of the metal. These high temperatures play an important part in polishing, the formation of the Beilby layer, the machining of metals and a number of other physical processes. Some low frcition materials are also described.

539.6

6100. A discussion on friction: Comments on the energetics of the frictional process. F. E. Simon. *Proc. Roy. Soc. A*, **212**, 477 (*May* 22, 1952).

539.

6101. A discussion on friction: Reply to Professor Simon's comments. F. P. Bowden. *Proc. Roy. Soc. A*, **212**, 477 (*May* 22, 1952).

539.

6102. A discussion on friction: Comments on the energy of deformation during sliding. A. J. W. Moore. *Proc. Roy. Soc. A*, **212**, 478 (*May* 22, 1952).

539.

6103. A discussion on friction: Comments on the work done in rolling friction. D. Tabor. *Proc. Roy. Soc. A*, **212**, 478–9 (*May* 22, 1952).

539.

6104. A discussion on friction: Influence of oxide films on metallic friction. R. Wilson. *Proc. Roy. Soc. A*, **212**, 450–2 (*May* 22, 1952).

The mechanism of metallic friction, in air, has been investigated for loads ranging from 0·003 to 10 000. The metals studied include Pt, Au, Ag, Cu, Sn, Pb, Zn; Cd, Mg, Al and Cr. The earlier work of Whitehead has been extended and simultaneous measurements made of the frictional force and the electrical resistance between the sliding surfaces. The results show that with most metals the natural oxide layer is sufficient to prevent metallic contact at very small loads. The degree of protection depends on a number of factors, such as the surface roughness, the thickness of the oxide film and in particular on the relative hardness of the oxide and the metal substrate. When sliding occurs solely on the oxide layers the friction is not necessarily less than that observed when appreciable metallic contact occurs. The surface damage is, however, greatly diminished on account of reduced metallic interaction.

539

6105. A discussion on friction: Comments on the paper by R. Wilson. H. Blok. *Proc. Roy. Soc.* **212**, 480–2 (*May* 22, 1952).

539

6106. A discussion on friction: Note on Professor Blok's comments. D. Tabor. *Proc. Roy. Soc.* **212**, 482 (*May* 22, 1952).

539.62

107. A discussion on friction: Relation between ction and hardness. A. J. W. MOORE AND W. J. MCG. EGART. *Proc. Roy. Soc. A*, **212**, 452–8 (*May* 22, 52).

Although hardness has little effect on friction ere is evidence that in general the friction is less th harder metals. Experiments on a carefully lected series of Cu–Be alloys show that the friction creases linearly with the hardness. For a given ad the amount of plastic deformation at the points intimate contact is greater for a soft metal. It is ggested that this deformation facilitates disruption the oxide film so that for softer metals the pro- rtion of oxide-free junctions is greater. The sulting frictional force is therefore higher. A.

539.62

108. A discussion on friction: Effect of included ide films on the structure of the Beilby layer. A. J. W. OORE AND W. J. MCG. TEGART. *Proc. Roy. Soc. A*, 2, 458–9 (*May* 22, 1952).

Experiments show that during repeated sliding, ide is included to a considerable depth beneath the rface of the metal. Subsequent annealing at high mperatures shows that the included oxide particles event grain growth in the surface layers. This ocess may be largely responsible for the fine grain ze of the Beilby layer. A.

539.62

109. A discussion on friction: Formation of bricant and other films on clean metal surfaces: A udy by electron diffraction. R. COURTEL. *Proc. oy. Soc. A*, **212**, 459–62 (*May* 22, 1952) *In French.*

In a recently published paper (1950), the author as collected the results of researches carried out ring the last few years on clean metal surfaces. hese have been obtained by grinding in a very high acuum (10^{-4} to 10^{-5} mm of mercury) within the ody of an electron diffraction camera. The surface ay be examined by diffraction immediately after reparation, and it is also possible to study the effect f the admission of controlled amounts of gas, inert r otherwise. With Fe, for example, it is found that e vapours of fatty materials are adsorbed and form riented films. On the other hand, with Ce an oxide formed which has not hitherto been isolated esquioxide Ce_2O_3 cubic). By observing the oxides nd their structural changes, it is also possible to etermine, in certain cases, the surface temperature eveloped by grinding. Details are given of an pparatus which contains a separate preparation hamber, so that the action of certain sulphurized ompounds, especially on clean surfaces, may be tudied at different temperatures. A.

539.62

110. A discussion on friction: Surface changes due o sliding. G. I. FINCH AND R. T. SPURR. *Proc. Roy. Soc. A*, **212**, 462–4 (*May* 22, 1952).

Metallic bearing surfaces on sliding become coated ith an amorphous Beilby layer formed by the mearing out of molten projections. The heating has een held to be due to the overcoming of friction etween the metals themselves. However, there are any examples of the formation of Beilby layers where there is no evidence of the occurrence of direct intermetallic contact and where the frictional forces must have been other than between metals. In practice a metallic bearing surface is invariably covered with an amorphous oxide layer. The load-carrying capacity of this layer depends largely on the rigidity of the underlying metal. It is, therefore, a particular virtue of the Beilby layer that in addition to its smoothness it is, in general, much harder than the underlying metal. The bearing metals in general use are more fusible than their oxides. The heat generated in the sliding of the oxide-covered metal pair leads first to the softening of the more fusible metal and the consequent rupturing of its oxide film. Intermetallic contact is, however, still prevented by the oxide film which remains intact on the more refractory, and consequently still rigid surface. It is well known that Beilby layers are formed on both surfaces of a sliding element, even when the metals have widely different melting-points. This is due to the high temperature developed at the asperities of the rougher surface as these slide in long tracks over the smoother surface. A.

539.62

6111. A discussion on friction: Friction and cohesion between single crystals of copper. A. T. GWATHMEY, H. LEIDHEISER, JR, AND G. P. SMITH. *Proc. Roy. Soc. A*, **212**, 464–7 (*May* 22, 1952).

Friction and adhesion experiments have been carried out between two large crystals of copper of controlled orientation from the surface of which all oxide had been removed. One crystal was in the form of a sphere and the other was a sphere with two flat surfaces cut parallel to particular planes. The coefficient of dry static friction between two (100) faces was greater than one hundred and between (111) faces was approximately twenty-five. The greater value for the (100) faces was attributed to the greater digging-in and the increased area of contact produced by slip as displacement occurred. Similar cohesion experiments showed that bonds were formed of the same strength as the parent metals. The rupture of the bond formed between crystals and the slip of the metal adjacent to the bond were studied. A.

539.62

6112. A discussion on friction: Wear processes on cemented carbide tools used in cutting steel. E. M. TRENT. *Proc. Roy. Soc. A*, **212**, 467–70 (*May* 22, 1952).

The particular conditions on the top surface of a cutting tool where the thin ribbon, or chip, of metal with a freshly exposed surface flows in contact with the tool over a relatively long path, lead to the generation of high temperatures at the friction surface. Consideration of the phenomena of wear on such tools presents a picture of the type of temperature gradient in the tool near the friction surface. A.

539.62

6113. A discussion on friction: Metallic wear. J. T. BURWELL AND C. D. STRANG. *Proc. Roy. Soc. A*, **212**, 470–7 (*May* 22, 1952).

Describes experiments on the wear between a cylindrical metal pin and a hardened steel disk. Under steady-state conditions at light loads it is

found that the volume V of material worn away is proportional to the load W, and the length L of path traversed so that $V = k'LW$. Since the real area of contact A may be written as $A = W/P_m$, where P_m is a strength property of the pin, the wear equation may be rewritten $V = k'LA/P_m = kLA$, where k is a constant for the surfaces. This relation suggests that, of the welded junctions formed at the interface and sheared during sliding a constant fraction is detached to form the wear particles. On this view an increase in load produces a proportional increase in the number of welds each of which remains approximately of constant size. This is supported by an examination of the wear particles. This mechanism would seem preferable to the atomic wear model suggested by Holm, which also yields a wear equation of the form $V = kLA$. At higher loads, in excess of an average pressure about one-third the hardness of the pin, a large increase in the wear rate is observed. It is suggested that this is primarily due to the fact that the true contact area has become such a large fraction of the apparent contact area which is available that a loose wear particle once formed is not able to get away without producing further particles in a self-accelerating process. These results are discussed in relation to the practical problem of running-in newly assembled machine parts. A.

539.62

6114. A discussion on friction: Notes on the adhesion of indium in impact. A. W. Crook. *Proc. Roy. Soc. A*, **212,** 482–3 (*May* 22, 1952).

539.62

6115. A discussion on friction: Comment on the frictional behaviour of porous metal impregnated with P.T.F.E. P. P. Love. *Proc. Roy. Soc. A*, **212,** 484 (*May* 22, 1952).

539.62

6116. A discussion on friction: Friction of diamond, graphite and carbon; the influence of adsorbed films. F. P. Bowden, J. E. Young and G. Rowe. *Proc. Roy. Soc. A*, **212,** 485–8 (*May* 22, 1952).

The substances were outgassed *in vacuo*. With C and graphite the friction rises to a high value when the surface films normally present are removed by outgassing. A small pressure of O or water vapour restores the friction to its normal value. These results may be compared with Savage's observations on the wear of graphite. This change is reversible on pumping out without heating, suggesting that a major factor is the physical adsorption of surface films. The friction of diamond surfaces in air is low, but on removing the surface films *in vacuo* it rises to a high value and the shear strength of the junction is comparable with the bulk strength of diamond. Large-scale seizure does not occur as with outgassed metals, since the deformation in the region of contact is elastic and the area of contact remains small. If the diamond slides on a metal such as Pt so that plastic deformation is possible, the area of contact becomes large and the friction is correspondingly increased. A.

539.62

6117. A discussion on friction: Frictional properties of plastics. K. V. Shooter. *Proc. Roy. Soc. A*, **212,** 488–91 (*May* 22, 1952).

The frictional properties of a group of linear polymers were investigated over a range of load from 0·04 to 10 000 g. Deviations from Amontons's law occur at light loads. At heavy loads the frictional force is proportional to the area of contact. The force per unit area of contact resisting sliding can be calculated from the frictional force, and is found to be roughly equal to the specific shear strength of the plastic itself. This suggests that strong adhesion occurs over the region of contact, and that, during sliding, shearing occurs within the bulk of the plastic rather than at the interface. The corollary to this, the transfer of material between the two surfaces, has been demonstrated. The frictional properties of plastics can thus be explained by the theory developed by Bowden and his co-workers for the friction of metals. An important exception to these conclusions is polytetrafluorethylene. The force per unit area of contact resisting sliding is much less than the shear strength of the plastic itself.

539.6

6118. A discussion on friction: Friction between single fibres. N. Gralén. *Proc. Roy. Soc. A*, **21** 491–5 (*May* 22, 1952).

Single textile fibres are of the order of magnitude of 10 to 50 μ in thickness. The measurement of friction between them in a longitudinal direction therefore offers some experimental difficulties. Two forms of apparatus have been designed. One measures the friction between two fibres crossed at a small angle. The second one measures the friction in a twist of two fibres. It has been found by both methods that the dependence of the frictional coefficient on the normal load is considerable. With increasing load the coefficient decreases. For the study of the nature of friction the small dimensions of the fibres might become very useful. Two crossing fibres with cylindrical cross-sections give a well-defined contact which is difficult to obtain with plane surfaces. The almost parallel cylinders (twist method) give in the ideal case a well-defined line-contact.

539.

6119. A discussion on friction: Some comments on the paper by Dr. N. Gralén. K. R. Makinson. *Proc. Roy. Soc. A*, **212,** 495–6 (*May* 22, 1952).

539.

6120. A discussion on friction: Some notes on the adhesion and friction of non-metals. A. C. Moore. *Proc. Roy. Soc. A*, **212,** 497 (*May* 22, 1952).

539.

6121. A discussion on friction: Mechanism of boundary lubrication. D. Tabor. *Proc. Roy. Soc.* **212,** 498–505 (*May* 22, 1952).

Shows how the theory of metallic friction, discussed in earlier papers (preceding abstracts), is modified by the presence of boundary films. Over the regions of contact the load is mainly supported by the boundary film, but some metallic interaction occurs through with the formation of minute metallic junctions. These junctions contribute to the frictional resistance and play a major part in the wear of lubricated surfaces. The effect of temperature shows that the most effective lubrication is provided by a soft boundary film which possesses a close-packed strongly oriented structure. When the film melts, a marked

crease in friction and metallic interaction occurs. or this reason fatty acids are generally more effective an hydrocarbons or alcohols, since they can react th the surface to form metallic soaps of relatively gh melting-points. This chemical attack generally curs via the metal oxide film which is present on the rface. The soap formation and the difference tween a physically adsorbed and a chemically rmed layer have been investigated by radioactive ethods. A recent study has been made of the metal ansference from one surface to the other as sliding kes place, using radioactive metals. The results ain show that at the melting-point of the lubricant m a marked increase in pick-up and friction occurs. new observation is that at still higher temperatures second deterioration in lubricating properties curs, corresponding to the desorption of the bricant film. Although the surface is flooded with lubricant the friction and surface damage are mparable with that observed with unlubricated rfaces. These effects are reversible on cooling and rrespond to changes in state of the lubricant film. milar changes are observed in electron diffraction udies of the structure and orientation of boundary ms. The properties which a good boundary bricant should possess are discussed. A.

539.62

122. A discussion on friction: Some comments on e paper by D. Tabor. J. W. MENTER. *Proc. Roy. oc. A*, **212**, 516 (*May* 22, 1952).

539.62

123. A discussion on friction: An optical method of easuring the thickness of adsorbed monolayers. S. COURTNEY-PRATT. *Proc. Roy. Soc. A*, **212**, 05–8 (*May* 22, 1952).

The interferometric techniques developed by olansky have been used to study films adsorbed on olid surfaces. A monomolecular layer of fatty acid as spread by the retraction technique over part of a elected facet of a piece of mica. A highly reflecting yer of silver was then deposited on both sides of the ica specimen, and the thickness of the acid layer etermined by multiple reflection interferometry. he values so obtained were in agreement with X-ray ata on the length of the fatty-acid molecule. Exam- ation showed that the layers were uniform in ickness; polymolecular layers were absent. The ethod provides direct and independent evidence at molecules of a fatty acid, spread by the retraction chnique, are adsorbed on a solid surface as a niform monomolecular layer. A.

539.62

124. A discussion on friction: Effect of surface ructure, composition and texture on friction under boundary conditions. F. T. BARWELL. *Proc. Roy. Soc. A*, **212**, 508–12 (*May* 22, 1952).

The coefficient of friction of surfaces lubricated under boundary conditions may be profoundly affected by such factors as the degree of working of the substrate material, the nature of the oxide film and the degree of roughness of the surface. Experiments are described wherein the frictional behaviour of surfaces of stainless steel specimens prepared in various ways was compared. The worked surface layers in these particular experiments appear to increase the value of the coefficient of friction, but the effect of surface texture is of predominant importance. The effect of different oxide films is best illustrated by reference to pure Al, the surface of which has been oxidized under different environmental conditions. The constitution of the oxide film formed is modified with a consequent effect on boundary friction. When the friction of rough and smooth surfaces is compared, the difference in behaviour appears to be qualitative rather than quantitative. A.

539.62

6125. A discussion on friction: Mechanism of action of extreme pressure lubricants. C. G. WILLIAMS. *Proc. Roy. Soc. A*, **212**, 512–16 (*May* 22, 1952).

Under progressively increasing load the oil film between sliding metals eventually becomes discontinuous and metallic contact begins to occur. The loading practicable without serious surface damage can be increased many-fold by using a lubricant containing an additive capable of reacting chemically with the sliding surfaces to provide emergency protection. The reaction is accelerated by the sharply rising temperature associated with incipient seizure, and the protective product is formed in just those places where temperatures and pressures rise to values which are extreme relative to those typical of hydrodynamic lubrication. For example, a chlorinated hydrocarbon is readily soluble in mineral lubricants and is inert towards most metals under the less severe conditions of lubrication. Under the thermal stimulus of incipient localized seizures the metal chloride forms at and protects the hot spots. The majority of metal chlorides are easily sheared solids below their melting-points, which are relatively low. Metal sulphides and oxides are examples of comparatively refractory materials which have been shown to possess extreme pressure properties. A.

539.62

6126. A discussion on friction: Variation with load of the coefficient of friction and metallic transfer under conditions of boundary lubrication. W. HIRST, M. KERRIDGE AND J. K. LANCASTER. *Proc. Roy. Soc. A*, **212**, 516–20 (*May* 22, 1952).

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.115

127. Determination of the heat of dimerization of trafluoroethylene by a kinetic method. B. ATKINSON AND A. B. TRENWITH. Letter in *J. Chem. Phys.*, **20**, 754–5 (*April*, 1952).

The values of $\Delta H = -49{\cdot}8$ kcal and $\Delta S = 47{\cdot}4$ cal/° have been obtained for the reaction $2C_2F_4 = C_4F_8$ (at *c.* 550°C), the energy of activation and the

steric factor having been calculated as $E = 25{\cdot}4$ kcal and $P = 3{\cdot}85 \times 10^{-4}$, respectively. F. LACHMAN

541.115

6128. Measurement of the heat of dissociation of fluorine by the effusion method. H. WISE. Letter in *J. Chem. Phys.*, **20**, 927 (*May*, 1952).

The value of $\Delta H_{298°} = 39{\cdot}9 \pm 0{\cdot}8$ kcal/mole has been obtained for the reaction $F_2(g) = 2F(g)$.

F. LACHMAN

541.121

6129. The 4-dimensional analogue of the tetrahedron and sphere, in relation to questions of physico-chemical equilibria. E. JÄNECKE. *Z. phys. Chem.*, **199**, 209–24 (*Feb.*, 1952) *In German.*

Mixtures of 5 substances can be presented 4-dimensionally as a body between 5 points at equal distances, which gives in 3-dimensional projection a tetrahedron with a central point. Analogous to a section through a tetrahedron, which is a triangle or a quadrangle, a section through a 5-cell is a tetrahedron or a prism. The 5-cell can be considered as a combination of an infinite number of tetrahedra or prisms. The prisms are used for the formation of the phase diagrams of mixtures of $(Na_2K_2Mg)(Cl_2SO_4)$. The diagrams are shown for 25°, and a wire model for 0° to 120°. The analogue of the sphere surrounding a tetrahedron with 4 circles through three corners, is a 5-dimensional sphere with 5 spheres around the 5 tetrahedra. In 3-dimensional projection these are 1 sphere and 4 rotational ellipsoids. Models of these are shown. C. TURNER

541.123.21

6130. Solution of the Gibbs–Duhem–Margules equation for binary mixtures. D. KAMKE. *Z. phys. Chem.*, **199**, 35–45 (*Jan.*, 1952) *In German.*

The general solution of the Gibbs–Duhem–Margules equation can be obtained from a consideration of the corresponding total and partial pressure curves. Simple formulae for the exact calculation of total and partial pressure curves from determinations of the composition of the vapour for different compositions of the liquid are given, and a method is indicated for the classification of total-partial pressure curves. A. J. MEE

541.123.5

6131. Effect of oxygen on the ferrous-ferric exchange reaction. L. EIMER, A. I. MEDALIA AND R. W. DODSON. Letter in *J. Chem. Phys.*, **20**, 743–4 (*April*, 1952).

It has been shown experimentally that, at variance with Weiss's suggestion [Abstr. 9042 (1951)], the rate of the $Fe^{++} \rightleftharpoons Fe^{+++}$ reaction is not significantly affected when the concentration of dissolved O is varied by a factor of 5000. F. LACHMAN

541.123.5 : 539.16.08

6132. Study of some exchange and recoil effects by the method of radioactive indicators. P. JORDAN. *Diss. E.T.H., Zürich, No.* 1942, 68 *pp.* (1951) *In French.*

A description of experiments designed to examine the processes characterizing the exchange of manganese atoms between compounds containing the atom in different valence states. Simple theoretical considerations are discussed. The second part describes an investigation, both experimental and theoretical, of the factors governing the extraction from the surface of a solid exposed to neutrons, of the radioactive recoil atoms which are produced.

H. H. GREENWOOD

541.12

6133. Tables of chemical kinetics. Homogeneous reactions. *Circ. Nat. Bur. Stand., No.* 510, 731 *pp.* (1951).

The purpose of these tables is a critically evaluated compilation of the available factual numerical data on rates and rate constants of homogeneous chemical reactions. Some thousands of reactions are dealt with in 174 tables, to which comments and literature references are appended. The work is part of a co-operative effort established by the International Unions of chemistry and physics and various national organizations.

541.12

6134. Kinetics of formation of oxide layer on zinc. W. J. MOORE. Letter in *J. Chem. Phys.*, **20**, 76 (*April*, 1952).

The dependence on O_2 pressure and on temperature of the rate of oxidation of Zn is consistent with the supposition that oxidation occurs by migration through the oxide layer of interstitial Zn ions formed by a process consisting of transfer of electrons from interstitial Zn atoms to adsorbed O_2 molecules.

A. D. LE CLAIR

ELECTROCHEMISTRY 541.13

541.13

6135. Electrochemical studies by the method of radioactive indicators (electrolyses in extremely dilute solutions). M. HAÏSSINSKY. *Experientia*, **8**, 125–3 (*No.* 4, 1952) *In French.*

The energy conditions for the formation of very thin electrolytic deposits from extremely dilute solutions can be explored by means of radioactive indicators. Rate of deposition or equilibria of distribution can be measured as functions of the potential applied to an inert electrode. Critical potentials are measured for Po, Bi, Pb, Ag for electrodes of various metals. Results are compared with those given by Nernst's equation; except for the case of Bi, the thermodynamic behaviour does not follow the equation at such concentrations. Heterogeneity of the electrodes causes overvoltage or undervoltage and influences the shape of the polarization curves. A detailed discussion and explanation of these curves is given. A. J. TAYLOR

541.13

6136. Electrolysis of thorium oxide. W. E. DANFORTH. Letter in *Phys. Rev.*, **86**, 416 (*May* 1, 1952)

The electrolysis of homogeneous ThO_2 by current of 100 mA/cm² (field strength ~50 V/cm) at 1300° with either W or Mo electrodes (the results are the same) produces a darkening of the crystal at the cathode end which proceeds towards the anode at ~1 mm per sec, electrolysis ceasing when the crystal is uniformly jet black (photograph included); the

ount of thorium electrolysed is $<10^{-2}$ mg in a stal 10 mm long, the fraction of current required ng $\sim 10^{-6}$, whereas with finely divided ThO_2 the ction may be as low as 10^{-6}. This difference is cussed. H. H. HODGSON

541.135

37. **Pattern observed in electrolysis.** B. MISHRA. *lian J. Phys.*, **25**, 277–8 (*June*, 1951).

Very dilute solutions of HCl, H_2SO_4, $CuSO_4$ and Cl were electrolysed in a rectangular trough. gular linear patterns were produced by the chemical ion of chlorine and sulphate ions on the anode ite and by the deposit of sodium and copper ions the cathode plate. Evolution of hydrogen ions in form of linear vertical patterns was also noticed the cathode plate. From the observations it is ggested that the motion of ions takes place in crete layers under the action of the electric field. A.

541.135.5

38. **Electrode reactions in alternating fields. I. e "a.c." active space.** B. BREYER AND S. HACOBIAN. *ust. J. Sci.*, **14**, 118–20 (*Feb.*, 1952).

The expression for the a.c. active space arising from nsiderations of the diffusion process (or: the easure of the quantity d appearing in equations for dynamic capacitance) is derived. For a perfectly versible process, the average active space becomes $= \frac{1}{2}\sqrt{D/\omega}\,.\tanh\frac{1}{2}\phi_0$, where D is the diffusion efficient, ω the coefficient in $\Delta V = \Delta V_0 \cos \omega\tau$ e sinusoidal potential superimposed), and $\phi_0 = F.\Delta V_0.\cos\omega\tau)/(RT)$. Calculated values of d_0 (and for a non-reversible process) for Tl^+, Cd^{++} and $^{+++}$ at various frequencies and at different a.c. ltages are tabulated. F. LACHMAN

541.135.5

39. **Experimental apparatus for the study of the charge of electrolytic anions by gaseous ions.** EYRAUD AND P. GILLY. *C.R. Acad. Sci.* [*Paris*] **4**, 1553–5 (*April* 7, 1952) *In French.*

An electrolytic cell is described in detail with 2 agrams, in which the anode is an ionized gas for discharge of anions, and the electrolyte is 38% ueous H_2SO_4; the latter enables cooling in a ostat at $-68 \pm 0{\cdot}5$°C, a temperature at which the rtial pressure of the water vapour is almost negligible. It is shown how the difficulties of previous rkers have been surmounted. H. H. HODGSON

541.135.5

40. **Discharge of electrolytic anions by gaseous ns.** C. EYRAUD AND P. GILLY. *C.R. Acad. Sci. aris*] **234**, 1614–16 (*April* 16, 1952) *In French.*

The effects resulting from the passage of a definite antity of electricity of the order of 1 to 3 mA in electrolytic apparatus previously described receding abstract) where the anode is an ionized s, are compared with those when a Pt anode is ed. Perdisulphuric acid is formed when the anode gaseous oxygen or hydrogen, but is absent when a tallic anode is employed, according to the probable chanism: $HSO_4^- \rightarrow e^- + HSO_4$, and $2HSO_4 \rightarrow O_8^{--} + 2H^+$. H. H. HODGSON

541.135.6

6141. **Direct current polarization of the iodine-iodide-redox potential at platinum for excess of foreign electrolyte.** K. J. VETTER. *Z. phys. Chem.*, **199**, 22–34 (*Jan.*, 1952) *In German.*

D.c. polarization measurements are recorded for the I_2–I' redox system with 1N H_2SO_4 excess (foreign electrolyte) at Pt under defined conditions of diffusion in a rotating apparatus (illustration included). From the c.d.-potential curves for experimental limiting c.d.'s, it appeared that predominant diffusion polarization occurred. The limiting c.d.'s exhibited concentration dependence, and no sign of reaction arrest was observed. The equilibrium constant of the reaction $I_2 + I' \rightleftharpoons I_3$ was determined from the equilibrium potentials. Only approximate values for the exchange c.d.'s could be obtained, since these were appreciably greater than the limiting c.d.'s. There are 5 sets of curves. H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

6142. **Photochemical processes in alkali halide crystals.** W. MARTIENSSEN. *Z. Phys.*, **131**, 488–504 (*No.* 4, 1952) *In German.*

The reaction products in alkali halide crystals due to u.v. or X-ray irradiation are studied by measurement of absorption spectra. Results confirm earlier work on additively coloured crystals but also provide further explanation of the processes involved.

G. F. J. GARLICK

541.14

6143. **Primary process in acetone photolysis and activation energy for the decomposition of acetyl radical.** D. H. VOLMAN AND W. M. GRAVEN. Letter in *J. Chem. Phys.*, **20**, 919 (*May*, 1952).

Experiments on the irradiation of mixtures of acetone and butadiene agree with a completely free radical mechanism for the photolysis of acetone. The quantity of ethane formed decreases as the butadiene content of the mixture increases, so that intramolecular decomposition cannot occur to any significant extent in the wavelength range 2300–3400 Å. If the primary process is $(CH_3)_2CO \rightarrow CH_3 + CH_3CO$, it seems probable that all the CH_3 radicals add on to the butadiene. The quantity of CO in the products also decreases with increasing butadiene content, and this may be due to addition of CH_3CO to butadiene. The yield of CO is therefore a measure of the relative rates of decomposition of CH_3CO and addition of CH_3CO. From the equations $CH_3CO = CH_3 + CO$ and $CH_3CO + C_4H_6 = C_4H_6CH_3CO$, $R_{CO}/R_{add} = k_1/k_2[C_4H_6]$ and $E_1 - E_2 = 8{\cdot}1$ kg-cal per g-mol in the range 100°–120°. E_2 is known to be approx. $5{\cdot}4$ kg-cal per g-mol, so that E_1 is approx. $13{\cdot}5$ kg-cal per g-mol. A. J. MEE

541.15

6144. **Radiation sensitivity of benzene-d_6.** S. GORDON AND M. BURTON. Letter in *Science*, **115**, 406 (*April* 11, 1952).

Benzene-d_6 is more resistant than benzene to high-

energy radiation. $G(D_2) \sim 0{\cdot}011$, $G(H_2) \sim 0{\cdot}037$; $G(C_2D_2) \sim 0{\cdot}013$, $G(C_2H_2) \sim = 0{\cdot}022$.

C. B. ALLSOPP

541.15

6145. Blue glass which fades upon nuclear radiation. K. O. Otley and W. A. Weyl. Letter in *J. Appl. Phys.*, **23**, 499 (*April*, 1952).

Glasses such as those with borate base show a blue colour when S_2 molecules are present. On excitation by high-energy radiation the colour is bleached, which suggests that the S_2 molecules trap excited electrons to become colourless ions. G. F. J. GARLICK

541.15 : 548.736

6146. Changes of crystal structure on bombardment with α-particles. B. Stech. *Z. Naturforsch.*, **7a**, 175–85 (*Feb.*, 1952) *In German.*

Changes of structure were followed by taking X-ray powder photographs. After α-irradiation graphite, selenium, some sulphides and halides showed no changes; $K_2Mn_2O_7$, AsO_3, anthracene and several other organic compounds showed a fall of intensity of high-order lines like that due to thermal agitation of atoms. No change occurred after comparable irradiation with 40 kV X-rays. Recoil of nuclei from α-particles cannot explain the magnitude of the effect, which is ascribed to ionization. The relation of the effect to crystal structure is discussed.

A. R. STOKES

DISPERSIONS COLLOIDS . ADSORPTION 541.18

541.183.5

6147. Adsorption of cations by metals, demonstrated by radioactive tracers. J. Palacios and A. Baptista. *C.R. Acad. Sci.* [*Paris*] **234**, 1676–7 (*April* 21, 1952) *In French.*

Exchange of cations is shown experimentally by means of radioactive tracers when the metals Pt, Pd, Au, Al, Cu, Pb, Fe and Ni are immersed in a solution of $Zn^{65}SO_4$, and tested afterwards by the Geiger–Müller counter. The effect is relatively slight for the noble metals, but appreciable for the others, and this result is held to establish exchange of cations during adsorption in the second case, and as evidence in support of the Palacios theory that electrode potentials are produced by adsorption cations. Data are given for Pb and an autoradiograph for Al is included.

H. H. HODGSON

541.183.56

6148. Particular forms of the adsorption isotherm of methane on graphite and various other bodies. L. Bonnetain, X. Duval and M. Letort. *C.R. Acad. Sci.* [*Paris*] **234**, 1363–6 (*March* 24, 1952) *In French.*

The temperature range covered was −166° to −195°C. The quantity adsorbed, when plotted as a function of pressure, showed 3 distinct steps. These are attributed to the formation of 1st, 2nd and 3rd adsorbed layer. Similar results are obtained for adsorption on MoS_2, $CdCl_2$, CdI_2 and $HgBr_2$.

L. G. CARPENTER

CHEMICAL STRUCTURE 541.2/.6

541.5

6149. The hydrogen bond in an amide link. A. Elliott. Letter in *J. Chem. Phys.*, **20**, 756 (*April* 1952).

Objections to the proposed folded structures for α-proteins and polypeptides on the grounds of non-linearity in the N–H . . . O hydrogen bonds are apparently overruled by recent infrared evidence of angular N–H . . . O bonds in simpler structures.

H. H. GREENWOOD

541.64 : 535.371 : 535.34

On the proof of defined reversible associates ("reversible polymerizates") of acridinorange by absorption and fluorescence measurements in aqueous solution. *See Abstr.* 5674

541.64 : 537.22

6150. Influence of electric charges on the behaviour of high polymers. W. Kuhn. *Z. angew. Phys.*, 4, 108–19 (*No.* 3, 1952) *In German.*

A relation is derived for the mean square distance between ends of chain-molecules and for the force necessary to change this distance. The effect of charges on the (ionized) molecules is discussed and the influence thereof on intrinsic viscosity and double refraction in solution. These quantities are also dependent upon concentration. The influence of electric charges on chain-molecules which form a three-dimensional network is considered: a small degree of ionization is sufficient to stretch out fully the connecting links. This effect is reversible. It is suggested on the basis of several arguments that this is the principle of muscle-contraction.

A. J. TAYLOR

541.64 : 539.13

Shape and mobility of chain molecules and their meaning for the states of orientation in high polymers. *See Abstr.* 5970

LABORATORY APPARATUS 542.1/.7

542.4

6151. Rectification of ideal ternary mixtures. H. Hausen. *Z. angew. Phys.*, **4**, 41–50 (*Feb.*, 1952) *German.*

CHEMICAL ANALYSIS 543/545

545

6152. Polarographic measurements of oxygen concentration in vivo. M. Mochizuki. *Monogr. Sci. Res. Inst. Appl. Elect.*, *No.* 2, 39–56 (1951).

A polarizing cell of Ringer's solution, using platinized or bright Pt electrodes, is described in detail. With a solution of known O_2 content as standard, the voltage-current characteristics (d.c.) of the cell are measured. A theoretical equation for these curves is developed from the standpoint of reaction rate, and agrees with experimental results. A smaller cell (working diagram given) with micro-electrodes is used to measure O_2 concentration, and in, the brain cortex of some live animals

rves given show how this varies as anaesthetics are ninistered (ether, urethan, evipan–Na) and the ct of O_2 inhalation. O_2 concentration in the brain tex showed a larger fluctuation than that on the tex under these stimuli. D. V. MABBS

545.37

3. Galvanic determination of traces of oxygen in es. P. HERSCH. Letter in *Nature* [*Lond.*] **169,** –3 (*May* 10, 1952).

Cathodic reduction of oxygen is investigated in nection with gas analysis, for which purpose hodes half-immersed in the electrolyte under N_2 l H_2 are used in suitably designed cells (diagram luded). It is found that otherwise difficultly ectable traces of O_2 in the gas phase, such as $^{-6}$ ml/ml, are capable of giving substantial and ily measurable currents. Manipulation details given, and with the cell described, O_2 in high-ity N_2($< 0{\cdot}001\%$ O_2) is rapidly determined with uncertainty of $\sim 0{\cdot}00005\%$. H. H. HODGSON

545.721

4. An oxygen meter based on magnetic con-rations. A. NAUMANN. *Siemens-Z.*, **26,** 134–40 *ril*, 1952) *In German.*

A detailed description, with 14 diagrams and illustrations, is given of a meter for the quantitative determination of oxygen in a mixture of gases, which is based upon the selective property that of all the technically important gases only oxygen is paramagnetic, the other gases being diamagnetic. H. H. HODGSON

545.81 : 778.6

6155. Determination of hydroxylamine in colour developers. W. BRUNE AND E. RIEGER. *Z. wiss. Photogr.*, **46,** 179–81 (*No.* 10–12, 1951) *In German.*

By the reaction of NH_2OH with ethyl acetate in the presence of NaOH, hydroxamic acid is formed, and this is converted to the red ferric complex for colorimetric determination. Accuracy appears to be $\pm$ 5%. S. T. HENDERSON

545.828

6156. On the arching of the photographic plate in the dark slide as a source of errors in quantitative spectral analysis. A. SCHÖNTAG. *Z. wiss. Photogr.*, **46,** 182–7 (*No.* 10–12, 1951) *In German.*

Variations in intensity ratio of a close pair of lines may be due to curvature of the plate. This curvature was shown to increase with decreasing relative humidity, owing to increasing shrinkage of the gelatine layer. S. T. HENDERSON

CRYSTALLOGRAPHY 548

548.0 : 539.32

7. Third order elastic coefficients in trigonal hexagonal crystals. F. G. FUMI. Letter in *s. Rev.*, **86,** 561 (*May* 15, 1952).

A table is given which completes, for all 32 crystal sses, the results of the derivation of those coeffi-ts previously given for only 25 of the crystal sses [Abstr. 627 (1952)]. The methods available their derivation are summarized. A. D. LE CLAIRE

548.23

8. Mosaic in crystals of synthetic corundum. YU. IKORNIKOVA. *Dokl. Akad. Nauk SSSR*, **81,** –5 (*No.* 3, 1951) *In Russian.*

Mosaic structure is found in boules of synthetic rundum, the size of individual crystallites ranging n 1 cm to 0·005 mm. The structure represents a ge between an ideal single crystal and a poly-stalline aggregate. A. L. MACKAY

548.5

9. Growth spirals on synthetic rubies. S. ELINCKX. *C.R. Acad. Sci.* [*Paris*] **234,** 1793–4 *ril* 28, 1952) *In French.*

hotographs show that the "spirals" on the (0001) are closed concentric equilateral triangles, ting from two nearby dislocations of opposite A. R. STOKES

548.5

0. Spiral growth patterns on apatite crystals. MELINCKX. Letter in *Nature* [*Lond.*] **169,** 841–2 *y* 17, 1952).

he spirals on the prism (10$\bar{1}$0) faces of yellow r-apatite were observed to form "razor-blade" figures with two long straight sides and two short curved ends. A. R. STOKES

548.51 : 551.574.1

6161. The rhombic habit of the NaCl microcrystals forming the nuclei for atmospheric condensation. L. FACY. *C.R. Acad. Sci.* [*Paris*] **234,** 1791–3 (*April* 28, 1952) *In French.*

The nuclei were found by electron microscope examination often to be flat tabular crystals limited by prism faces of high-order Miller indices. Similar nuclei were prepared artificially by very rapid evaporation of NaCl solutions, a process which produces the high degree of supersaturation necessary for the appearance of high-order habits. The (450) and (560) faces are the most commonly observed, and correspond to a critical speed of evaporation. R. S. PEASE

548.52

6162. Growth spirals on magnesium crystals. A. J. FORTY. Letter in *Phil. Mag.*, **43,** 481–3 (*April*, 1952).

These are observed by reflection phase contrast microscopy on crystals grown from the vapour, but only after an optimum exposure of the crystals both to air and to the plasticine in which they are mounted. The mechanism producing this enhanced visibility is not understood. A. D. LE CLAIRE

548.523

6163. Influence of the rate of evaporation of non-aqueous solutions of alkali halogenides on the appearance of the precipitated crystals. R. KERN. *C.R. Acad. Sci.* [*Paris*] **234,** 1379–80 (*March* 24, 1952) *In French.*

Describes experiments, similar to those carried out

on aqueous solutions [Abstr. 4740 (1952)], on NaCl-type salts in CH_3OH, C_2H_5OH, CH_3COCH_3, $CH_3COC_6H_5$, $C_4H_8O_2$. Slow evaporation gives cubes, higher rates octahedra, except for dioxane. The "critical evaporation rate" increases for a given solvent in the order: NaCl, KCl, KBr, NH_4I, KJ, RbI, and for a given salt in the above order. The formation of octahedra is proportional to the extent of solvation. C. TURNER

548.523

6164. Influence of the rate of evaporation of alkali halogenide solutions of the type CsCl on the appearance of the precipitated crystals. R. KERN. *C.R. Acad. Sci.* [*Paris*] **234,** 1696–7 (*April* 21, 1952) *In French.*

Aqueous solutions of NH_4Cl, NH_4Br, CsCl, CsBr and CsI are investigated in the same way as before [Abstr. 4740 (1952)]. A slow rate of evaporation gives (110), a higher rate (100). Dendrites prevent observations for ammonium salts. A small supersaturation gives thus crystal faces with a small electric field, i.e. planes containing positive and negative ions. For higher supersaturations crystal faces appear with strong electric fields. C. TURNER

548.538 : 548.74

6165. Overgrowths of alkali halides on $CaCO_3$ and $NaNO_3$. L. G. SCHULZ. *Acta Cryst.*, **5,** 264–5 (*March*, 1952).

Crystals of ten alkali halides were grown from vapour and from solution on cleavage surfaces of $CaCO_3$ and $NaNO_3$, and were examined by electron diffraction. Observed orientations are tabulated and considered from the point of view of the conditions (1) low-index planes parallel to the substrate, (2) electrical neutrality at the interface, and (3) atomic matching along rows of like ions. Only (3) is always satisfied. A. R. STOKES

548.54

6166. Striations on prism faces of quartz. G. VAN PRAAGH AND B. T. M. WILLIS. Letter in *Nature* [*Lond.*] **169,** 623–4 (*April* 12, 1952).

An explanation is offered for the formation of the striations on well-developed prism faces of quartz. A study of the surface topography, by interferometry, of natural and synthetic crystals shows that the striations can be attributed to different rates of spreading of growth sheets parallel and perpendicular to the *Z*-axis. S. TOLANSKY

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

6167. The electrostatic lattice energy of finite sections of heteropolar crystals. O. EMERSLEBEN. *Z. phys. Chem.*, **199,** 170–90 (*Jan.*, 1952) *In German.*

The method of determining the lattice energy of a neutral ionic crystal by its Madelung-constants is improved upon for simple linear, planar and 3-dimensional lattices, by taking numerical coefficients for the asymptotic dependence of this energy on the number of ion-pairs constituting the lattice. This is used for the calculation of the influence of the particle size on the electrostatic contribution to the work needed to split the crystal into its ion pairs. C. TURNER

548.7

6168. Heats of formation and of evolution o NaCl–NaBr solid solutions. V. HOVI. *Ark. Fys.*, **5** 61–7 (*Paper* 4, 1952).

The writer has applied Wasastjerna's theory [Abstr 5633–4 (1951)] to the calculations of the heat o formation of NaCl–NaBr solid solutions correspond ing to the equilibrium at 60°C. For these calculation the ion displacements in a NaCl–NaBr mixed crysta lattice were assumed, while the lattice was suppose to be characterized by a certain degree of local orde The theoretical results obtained for NaCl–NaBr soli solutions of different compositions have been com pared with the experimental data of Fineman an Wallace [Abstr. 996 (1949)]. It is shown tha Wasastjerna's theory leads in the present case to good agreement with experiment. From an equatio presented by the writer [Abstr. 5635 (1951)] som values have been calculated for the energy evolve from these mixed crystals when they transit from completely disordered state to another, which corr sponds to the degree of local order at 60°C.

548

6169. Temperature dependence of the structure [crystal] dislocation. H.-D. DIETZE. *Z. Phys.*, **13** 107–10 (*No.* 1, 1952) *In German.*

The equation of Peierls for the size of a dislocatio (1940) is modified to account for the temperatu motion of the lattice, assuming that the therm shifts are independent of inner stresses. It is fou that the thermal motion increases the size of a d location, thus lowering the limit of elasticity.

F. LACHMA

548

6170. Theory of the *F′*-centres. S. I. PEKAR AN O. F. TOMASEVICH. *Zh. Eksper. Teor. Fiz.*, **21,** 1218– (*No.* 11, 1951) *In Russian.*

The model of the *F′*-centre on which the investig tion is based consists of 2 electrons moving in t field of a positive point charge ("vacancy" of negative ion in the crystal or a positive excess in t interstitial space) in an inertia-polarized dielect medium. The energy and the ψ-function of the ba state of the *F′*-centre and its thermal dissociati energy are calculated, its stability criterion being a given. B. F. KRA

54

6171. *F′*-centres in alkali halide crystals. O. TOMASEVICH. *Zh. Eksper. Teor. Fiz.*, **21,** 122 (*No.* 11, 1951) *In Russian.*

In the paper reported in the preceding abstract t basic state of the *F′*-centres was calculated by a din variational method, wherein the ψ function of th electrons was approximated by the product of 2 sin electron functions: $\psi(r_1)$, $\psi(r_2)$. The ψ funct selected in this way does not take account of mutual correlation of the movement of the 2 electro The error so committed may be estimated, and als more accurate result obtained, by choosing a function of a more complex form depending $r_{12} = |\bar{r}_1 - \bar{r}_2|$. In this way the energies of dissoc tion of the *F′*-centre into the *F*-centre and pola

re calculated for NaCl, KCl and KBr crystals. se energies agree in the order of magnitude with erimental results. B. F. KRAUS

548.7

'2. Energy of thermal dissociation and the ground te of the double centre of coloration in ionic crystals. F. DEIGEN. *Zh. Eksper. Teor. Fiz.*, **21**, 992–1000 . 9, 1951) *In Russian.*

The behaviour of two neighbouring centres of oration in ionic crystals has been subjected to a antum-mechanical analysis. Strong interaction ween the centres of coloration results in the mation of a new system, viz. the double centre of oration. The energy of thermal dissociation and ground state parameters of this double centre ve been calculated. The temperature dependence the concentration of centres of coloration and of uble centres of coloration has been evaluated.

F. LACHMAN

548.7 : 535.375.5

Evidence of elastic longitudinal and transversal ves in cubic crystals. *See Abstr.* 5684

548.7 : 535.417

73. Screw dislocations in mica. S. AMELINCKX. tter in *Nature* [*Lond.*] **169**, 580 (*April* 5, 1952).

By multiple-beam interference methods a cleavage p is found on a mica surface which, starting at a ght of 140 Å, gradually disappears. This is inter- ted as evidence for a screw dislocation in muscovite ca. The effect has been confirmed on biotite.

S. TOLANSKY

548.7 : 539.11

Electronic energy bands in crystals. *See Abstr.* 5940

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See stract.* 6083–5

548.732 : 537.531 : 535.34

74. Transmission of X-rays through calcite near e Bragg angle. G. SCHWARZ AND G. L. ROGOSA. tter in *Phys. Rev.*, **86**, 421 (*May* 1, 1952).

Measurements show either an increase or a decrease the transmitted intensity at the Bragg angle, pending on whether the wavelength is large or small d on whether the crystal is thick or thin.

A. R. STOKES

548.733

75. A low-temperature X-ray camera. L. S. KAN ID B. G. LAZAREV. *Zh. Tekh. Fiz.*, **21**, 1542–3 o. 12, 1951) *In Russian.*

A small powder camera was constructed for use at e temperature of liquid N or H. The metal camera mplete with slits and with the film held to the out- le cylindrical surface by a metal band was suspended side a metal Dewar flask and was maintained at the nperature of the liquid by conduction through a rod. Four Be windows permitted the X-ray beam pass through the apparatus. No provision was ade for rotating the specimen. A. L. MACKAY

548.733

76. Universal specimen mount for pole figure termination using the Schulz–Decker technique. D. N. WILLIAMS AND D. S. EPPELSHEIMER. *Rev. Sci. Instrum.*, **23**, 229–31 (*May*, 1952).

A specimen mount is developed for use in the determination of pole figures using the Schulz–Decker Geiger counter technique. This specimen mount consists of five simply made parts. By suitable combination of these five parts the necessary rotation axes for both the transmission and reflection X-ray specimens are obtained. The application of the specimen mount is discussed and sample pole figures of cold rolled titanium and α-brass determined. A.

548.733 : 621.386.1

6177. Demountable X-ray tube for crystallography. T. B. RYMER AND P. G. HAMBLING. *J. Sci. Instrum.*, **29**, 192–4 (*June*, 1952).

A medium-power, demountable, shockproof tube is described. The construction is simple, and the various parts fit together to form a very rigid unit, which can be easily dismantled and reassembled without disturbing the focus. A.

548.734

6178. A note on the calculation of the absorption factors for single crystals with high absorbing power. D. GRDENIĆ. Note in *Acta Cryst.*, **5**, 283–4 (*March*, 1952).

Approximate formulae are given, and results calculated from these agree well with results of Howells's numerical method [Abstr. 8329 (1950)].

A. R. STOKES

548.734.3

6179. The absorption factor for rod-mounted specimens in the powder method of X-ray analysis. E. MØLLER AND E. JENSEN. *Acta Cryst.*, **5**, 345–8 (*No.* 3, 1952).

A method for calculating absorption factors for rod-mounted specimens in the powder method of X-ray analysis is described. Tables are given for the absorption factor as a function of θ and μr for different rod materials and values of (core radius)/(specimen radius). The influence of the variables on the intensity ratio of two lines is discussed and information is given on the choice of experimental conditions for obtaining more accurate intensity ratios. Rod-mounted specimens are just as good as homogeneous specimens for many analytical purposes. A.

548.734.4

6180. Determination of interaxial angles of a triclinic crystal from a single setting. G. B. CARPENTER. Note in *Acta Cryst.*, **5**, 284 (*March*, 1952).

Describes a simple method of finding the angles α and β from a Weissenberg photograph with the c-axis as rotation axis. See M. J. Buerger. *X-ray Crystallography*. New York, John Wiley and Sons (1942) 377, 383. A. R. STOKES

548.735.4

6181. Determination of the parameter in the structure of olivine (forsterite) by the method of three-dimensional harmonic synthesis. N. V. BELOV, E. N. BELOVA, N. N. ANDRIANOVA AND R. F. SMIRNOVA. *Dokl. Akad. Nauk SSSR*, **81**, 399–402 (*No.* 3, 1951) *In Russian.*

Parameters differing by 0–0·02 from those of Bragg and Brown [*Z. Krist.*, **63**, 538 (1926)] are found,

giving Si–O and Mg–O distances which differ by up to 0·2 Å. See also Abstr. 5442 (1952).

A. J. C. WILSON

548.735.4

6182. Some remarks on J. Gillis's paper on phase determination by the Harker–Kasper method. Y. OKAYA AND I. NITTA. Note in *Acta Cryst.*, **5**, 291 (*March*, 1952).

See Gillis, Abstr. 4038 (1948), on the structure of oxalic acid dihydrate. A new method gives the same results, but the phase-determination process should leave two parameters arbitrary, not only one.

A. R. STOKES

548.735.44

6183. Optical methods in X-ray analysis. III. Fourier synthesis by optical interference. A. W. HANSON AND H. LIPSON. *Acta Cryst.*, **5**, 362–6 (*No.* 3, 1952).

For Pt II, see Abstr. 9141 (1951). A method of Fourier synthesis by optical interference is described, which involves the representation of a reciprocal-lattice section by an array of holes in an opaque plate. Intensities can be controlled by varying the orientation of mica plates between crossed nicols, while phase changes sufficient for the synthesis of centro-symmetrical projections are effected by interference between the fast and slow components into which the mica resolves the incident light. Experiments are described which illustrate the application of the method to those problems involving conventional Fourier synthesis, to the determination of structures by trial of sign combinations, and to the testing of proposed structures by means of error syntheses. A.

548.735.46

6184. Some critical tests of the use of mixed projections in crystal-structure determination. I. D. THOMAS AND D. MCLACHLAN, JR. *Acta Cryst.*, **5**, 301–6 (*No.* 3, 1952).

In view of the present activity in the development of methods for deciphering Patterson structures, and especially in view of the apparent success of several authors along theoretical lines, it seems worthwhile to test at least one of these methods upon carefully chosen structures whose solutions are known. Without correlating the various methods or pointing out wherein they differ, the method of mixed projections is tested upon (*a*) a hypothetical structure of chlorine atoms; (*b*) hexamethylene-diamine dihydrobromide; (*c*) hexamethylene-diamine dihydrochloride; and (*d*) K_2CuCl_3. This work illustrates the two facts that are anticipated on theoretical grounds: (1) Ambiguities occur because of accidental coincidences, as well as near coincidences. (2) Difficulties in interpretation arise when one component of the translation vector is one-half or one-quarter of a cell translation, owing either to space group conditions or the characteristics of the structure. However, it is apparent that in any case the method is a very effective aid in simplifying the solution of complicated structures. A.

548.735.46

6185. The height of the vector rods in the three-dimensional Patterson of haemoglobin. F. H. C. CRICK. *Acta Cryst.*, **5**, 381–6 (*No.* 3, 1952).

A method is described for calculating the average height of the vector rods in the 3-dimensional Patterson of haemoglobin. The calculations have been carried out for the α-helix. They show that the simple models previously considered for haemoglobin give peaks which are too high, and that to obtain even rough agreement either less than about half the protein must be put into chains parallel to the *X* axis or considerable irregularity must be introduced. The evidence suggests that the folded polypeptide chain does not run in one direction for more than 20 Å at a stretch. A.

548.735.

6186. Particle size distribution from small-angle X-ray scattering. J. RISEMAN. *Acta Cryst.*, **5**, 193–(*March*, 1952).

A solution of the integral equation describing the intensity of X-ray scattering at low angles by a non-uniform collection of independently scattering spherical particles is given. The final result is in a form such that the particle-size distribution can be calculated by integration. The resolvent kernel, which solves the integral equation, is shown to be a combination of half-integral order Bessel functions and therefore obtainable from known tables. Utilizing the known scattering form for a single-sized group of spherical particles as illustration, the expected δ-function type of distribution is shown to result. The result obtained here can also be applied to the visible light scattering of dilute solutions of polydisperse macromolecules. A.

548.735.7 : 539.4.01

6187. The separation of cold work distortion and particle size broadening in X-ray patterns. B. E. WARREN AND B. L. AVERBACH. Letter in *J. Appl. Phys.*, **23**, 497 (*April*, 1952).

If the line profiles of powder diffraction lines be represented by Fourier series, the variation of the given Fourier component with order of diffraction can be used to separate distortion and size effects, without any assumptions about line shapes. A. R. STOKES

548.735.7 : 539.4.01

6188. The effects of lattice imperfections on X-ray line broadening. M. S. PATERSON. Letter in *J. Appl. Phys.*, **23**, 499–500 (*April*, 1952).

A discussion of Warren and Averbach's use of Fourier components of line profiles [Abstr. 675 (1950)]. A. R. STOKES

548.735.7 : 539.4.01

6189. X-ray line broadening from cold-worked iron. J. H. AULD AND R. I. GARROD. Letter in *Nature* [*Lond.*] **169**, 579–80 (*April* 5, 1952).

Measurements of line breadths, with special precautions, on specimens of iron filings and stretched iron wire indicate that nearly all the broadening is due to lattice strains rather than to small particle size. A. R. STOKES

548.736 : 541.1

Changes of crystal structure on bombardment with α-particles. *See Abstr.* 6146

548.736:

6190. The reduction of the crystalline perfection of graphite by grinding. G. E. BACON. Note in *Acta Cryst.*, **5**, 392 (*No.* 3, 1952).

548.736.1

)1. The crystal parameters of beryllium. E. A. ?EN. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 294–5 *pril*, 1952).

Many apparently conflicting values have been given, t when expressed in terms of the true Ångström t, at a given temperature, they all agree apart from iations due to impurities. For 99·8% Be, at °C, $a = 2{\cdot}2858_5$ Å; $c = 3{\cdot}5847_0$ Å; $c/a = 1{\cdot}5682_1$.

A. R. STOKES

548.736.1

)2. X-ray diffraction of heat-treated carbon cks. H. T. PINNICK. Letter in *J. Chem. Phys.*, **20**, 5–7 (*April*, 1952).

For particle sizes 50–3000 Å, the average crystallite meter, obtained from half-widths of asymmetric es, is about one-third of the particle size. The chanism of crystal growth is discussed: see anklin, Abstr. 9814 (1951). A. R. STOKES

548.736.1 : 537.542

The texture of diamonds used for counting α, β, or γ rticles as found from divergent-beam X-ray photo-aphs. *See Abstr.* 5853

548.736.3

)3. The structure of the ordered solid solutions –Au and Cu–Pt. I. L. APTEKAR. *Zh. Eksper. or. Fiz.*, **21**, 910–16 (*No.* 8, 1951) *In Russian.*

Starting from the theory of A. H. Wilson (1938) a e-centred cubic lattice of a solid solution of equal mbers of 2 kinds of atoms ordered in layers parallel (001) and (111) is examined. Deformations with formation of tetragonal or rhombohedral super-uctures correspond respectively to ordered CuAu d CuPt solutions. The cell dimensions (for defor-tion without change of volume) are obtained in ms of σ, the degree of order. For tetragonal tortion (001 layers) d_{001} is found to depend linearly σ as found by experiment. Thus the assumption t in the alloy CuAu atoms are disordered in the planes is incorrect as it leads to a quadratic pendence of d_{001} on σ. A. L. MACKAY

548.736.3

)4. An X-ray study of boron nitride. R. S. PEASE. *ta Cryst.*, **5**, 356–61 (*No.* 3, 1952).

The crystal structure, accurate unit-cell dimensions, d the thermal expansion of boron nitride are ablished. The presence of packing faults is shown, d the similarity of boron nitride to graphite in this d other respects is demonstrated. The nature of the N bond is discussed in terms of two possible models. A.

548.736.4

)5. On the crystallography of Cu(OH)Cl. W. WACKI AND K. MAGET. *Experientia*, **8**, 55 (*No.* 2, 52) *In German.*

Leafy crystals (½–1 mm in greatest dimension) were pared by heating $CuCl_2 . 2H_2O + CaCO_3$ at °C for 48 hours; they hydrolyse readily to $Cl_2 . 3Cu(OH)_2$. Goniometric measurements wed them to be monoclinic, class $2/m$, $\beta = 115° 55'$, ne of leaf (100); rotation and Schiebold–Sauter otographs gave $a = 6{\cdot}11$, $b = 6{\cdot}67$, $c = 5{\cdot}51$ Å (?,) $Z = 4$, space group $P2_1/c$. The measured density is 3·78, calculated 3·79 g/cm³. A. J. C. WILSON

548.736.4

6196. The crystal structure of sulfur dioxide. B. POST, R. S. SCHWARTZ AND I. FANKUCHEN. *Acta Cryst.*, **5**, 372–4 (*No.* 3, 1952).

Oscillation diagrams have been obtained of SO_2 single crystals at -130 ± 5°C. The unit cell is orthorhombic and contains 4 molecules. Cell dimensions are: $a = 6{\cdot}07$, $b = 5{\cdot}94$, $c = 6{\cdot}14$ Å (all $\pm 0{\cdot}01$ Å). The most probable space group is *Aba*. The four S atoms in the unit cell lie in face-centred positions. The parameters of the O atom are: $x = 0{\cdot}140$, $y = 0{\cdot}150$, $z = 0{\cdot}118$. The length of the S–O bond is $1{\cdot}430 \pm 0{\cdot}015$ Å, the intramolecular O–O distance is $2{\cdot}46 \pm 0{\cdot}01$ Å; the O–S–O angle is $119° \pm 2°$. A.

548.736.4

6197. The crystal structure of hydrazinium bromide, N_2H_5Br. K. SAKURAI AND Y. TOMIIE. Note in *Acta Cryst.*, **5**, 289 (*March*, 1952).

Space-group probably $C2/c$; $a = 12{\cdot}85$; $b = 4{\cdot}54$; $c = 11{\cdot}94$ Å, $\beta = 110° 16'$. 8 mols per unit cell. Atomic co-ordinates and interatomic distances are given. A. R. STOKES

548.736.4

6198. The crystal structure of hydrazinium chloride, N_2H_5Cl. K. SAKURAI AND Y. TOMIIE. Note in *Acta Cryst.*, **5**, 293–4 (*March*, 1952).

Space-group *Fdd*; $a = 12{\cdot}49$, $b = 21{\cdot}85$, $c = 4{\cdot}41$ Å; 16 mols per unit cell. Atomic co-ordinates and interatomic distances are given.

A. R. STOKES

548.736.4 : 537.226.2

6199. Crystal structure of the ferroelectric phase in $PbZrO_3$ containing Ba or Ti. G. SHIRANE AND S. HOSHINO. Letter in *Phys. Rev.*, **86**, 248 (*April* 15, 1952).

X-ray powder determinations for (Pb92·5–Ba7·5) ZrO_3 show the structure to be tetragonal in the anti-ferroelectric range below 175°C, rhombohedral in the ferroelectric range of 175–200°C, and cubic in the paraelectric range above 200°C. Intensity anomalies in the ferroelectric phase are interpreted as due to Zr or Pb displacement along the [111] direction. Similar characteristics have been confirmed for $Pb(Zr95–Ti5)O_3$ in its ferroelectric phase. Lattice spacing data are given. F. F. ROBERTS

548.736.4 : 537.311.33

6200. The fluorite phase in the system ZrO_2–CaO. Arrangement of flaws and the occurrence of electrical conductivity. F. HUND. *Z. phys. Chem.*, **199**, 142–51 (*Jan.*, 1952) *In German.*

Anomalous mixed crystals are made from the nitrates by heating at 1200° and 1450°. The cation lattice is found, by measurement of the lattice constants and the density, to be complete, but the anion lattice has open spaces. The temperature dependence of the resistance is measured for a mixture with 15·1 mol. % CaO, and the correlation between the arrangement of the open spaces and the conductivity is shown. C. TURNER

548.736.5

6201. Remarks on Vousden's structure of ferroelectric sodium niobate. R. Pepinsky. Note in *Acta Cryst.*, **5**, 288 (*March*, 1952).

The apparent contradiction between the ferroelectric properties and the space-group $P22_12$ is probably due to an error in space-group assignment: this might have arisen from twinning. A. R. STOKES

548.736.5

6202. The crystal structure of sodium thiosulphate pentahydrate. P. G. Taylor and C. A. Beevers. *Acta Cryst.*, **5**, 341–4 (*No.* 3, 1952).

This was determined by the use of 3-dimensional Patterson methods and refined by 2-dimensional Fourier synthesis. The unit cell dimensions are $a = 5{\cdot}94 \pm 0{\cdot}01$, $b = 21{\cdot}57 \pm 0{\cdot}05$, $c = 7{\cdot}53 \pm 0{\cdot}01$ Å, $\beta = 103° 58' \pm 5'$. The space group is $P2_1/c$. The structure shows a tetrahedral thiosulphate group, with a S–S distance of 1·97 Å and an average S–O distance of 1·48 Å. Each S atom is surrounded by an octahedral group of atoms; the external S atom is one member of one such group, but the remainder are O's of the thiosulphate groups or are water O's. These octahedral groups share edges with each other to form chains parallel to the a axis, and these chains are linked together sideways by sharing O's with, and by H bonding to, the S_2O_3 groups. A.

548.736.5

6203. The atomic arrangement and bonds of the gold-silver ditellurides. G. Tunell and L. Pauling. *Acta Cryst.*, **5**, 375–81 (*No.* 3, 1952).

The structures of sylvanite, calaverite and krennerite, the 3 Au–Ag ditellurides occurring naturally, are basically similar, although they have 3 different space-group symmetries. In all 3 minerals the Au and Ag atoms are surrounded by 6 Te atoms, which are not all at the same distance, however. In sylvanite and calaverite, each Te atom is surrounded by 3 Au or Ag atoms and 3 Te atoms. In krennerite, part of the Te atoms are surrounded by 3 Au or Ag atoms and 3 Te atoms, part by 1 Au or Ag atom and 5 Te atoms, part by 5 Au or Ag atoms and 1 Te atom. An analysis is given of the interatomic distances in terms of the resonating-valence-bond theory. A.

548.736.5

6204. The crystal structure of potassium bicarbonate, $KHCO_3$. I. Nitta, Y. Tomiie and C. H. Koo. Note in *Acta Cryst.*, **5**, 292 (*March*, 1952).

Space-group $P2_1/a$; $a = 15{\cdot}11$; $b = 5{\cdot}67$; $c = 3{\cdot}71$ Å; $\beta = 103° 45'$. Atomic co-ordinates, interatomic distances and bond angles are given.

A. R. STOKES

548.736.5

6205. Crystal structure of ilvaite [lievrite]. N. V. Belov and V. I. Mokeeva. *Dokl. Akad. Nauk SSSR*, **81**, 581–4 (*No.* 4, 1951) *In Russian.*

Orthorhombic, *Pbnm*, $a = 8{\cdot}82$, $b = 13{\cdot}07$, $c = 5{\cdot}86$ Å, $Z = 4 \times CaFe_2^{++}Fe^{+++}Si_2O_8(OH)$. A table of atomic parameters is given, with a drawing of the atomic arrangement. Compare T. Ito, *X-ray studies on polymorphism* (Tokyo, 1950, p. 151) and Y. Takeuchi, *X-rays*, **5**, 8 (1948). See also Abstr. 5442 (1952). A. J. C. WILSON

548.736.6

6206. The crystal structure of β dicalcium silicate. C. M. Midgley. *Acta Cryst.*, **5**, 307–12 (*No.* 3, 1952).

This was determined from X-ray oscillation, rotation and Weissenberg photographs. The mineral is monoclinic, space group $P2_1/n$, with cell dimensions $a = 5{\cdot}48 \pm 0{\cdot}02$, $b = 6{\cdot}76 \pm 0{\cdot}02$, $c = 9{\cdot}28 \pm 0{\cdot}02$ Å; $\beta = 94° 33'$. There are 4 molecules in the unit cell. The atomic co-ordinates were found by means of 2-dimensional Fourier projections along 2 axes. The relation of this structure to the orthorhombic β potassium sulphate and trigonal glaserite structures is discussed. A

548.736.6

6207. The structure of Ni_2Si. K. Toman. *Acta Cryst.*, **5**, 329–31 (*No.* 3, 1952).

The structures of a low- and high-temperature modification of Ni_2Si are determined. The former is orthorhombic (*Pbnm*) with $a = 7{\cdot}03$, $b = 4{\cdot}99$, $c = 3{\cdot}72$ Å and with 4 Ni_2Si in the unit cell. The latter is hexagonal ($C6_3m$) with $a = 3{\cdot}805$, $c = 4{\cdot}890$ Å, and with 2 Ni_2Si in the unit cell. A

548.73

6208. The crystal and molecular structure of diketene. L. Katz and W. N. Lipscomb. *Acta Cryst.*, **5**, 313–18 (*No.* 3, 1952).

The structure of diketene has been a matter of debate since the compound was first prepared in 1907. This study shows that the structure in the solid state is 3-buteno-β-lactone. Diketene crystallizes in the monoclinic system. The space group is $P2_1/c$ and there are four molecules per unit cell. Unit cell dimensions are $a = 4{\cdot}00$, $b = 20{\cdot}67$, $c = 5{\cdot}11$ Å, $\beta = 101{\cdot}8°$.

548.73

6209. The external form of the haemoglobin molecule. II. W. L. Bragg and M. F. Perutz. *Acta Cryst.*, **5**, 323–8 (*No.* 3, 1952).

Considerations of packing of molecules in various forms assumed by mammalian haemoglobin agree with deductions as to the general overall dimensions of the hydrated molecules based on X-ray diffraction effects and described in Pt I [Abstr. 5254 (1952)]. The following figures for types of haemoglobin crystals listed at the beginning of this paper indicate the degree of consistency between various estimates: type 1, either $50 \times 50 \times 75$ Å or $55 \times 55 \times 65$ Å; type 1 same as type 1; type 4, $56 \times 56 \times 72$ Å; type 1 $54 \times 54 \times 69$ Å. Though insufficient data are as yet available for deductions from the packing in the other types of molecule listed in this paper, the unit cell and symmetry are not inconsistent with these dimensions except in the case of foetal sheep haemoglobin which would appear to have a different structure.

548.7

6210. The crystal and molecular structure of "mercury diethylene oxide." D. Grdenić. *Acta Cryst.*, **5**, 367–72 (*No.* 3, 1952).

The application of the method of X-ray analysis has shown that the compound $\beta.\beta'$-oxido-diethyl mercury quoted in chemical literature under the name "mercury diethylene oxide" has a formula different from that ascribed to it. The crystal

monoclinic. The cell containing four molecules has the dimensions $a = 19{\cdot}45$, $b = 4{\cdot}46$, $c = 14{\cdot}67$ Å, $\beta = 120{\cdot}5°$. The space group is C_2^5–$C2/c$. The molecule occupying the position on a twofold symmetry axis in the lattice is a puckered twelve-membered ring. The bond angle C–Hg–C is only a few degrees less than 180°. Accepting the normal single bond length for C–C and C–O, the value of 2·14 Å was obtained for the Hg–C distance. It is characteristic that the O atom is closer to one Hg atom than to the other, the distances being $2{\cdot}21 \pm 0{\cdot}1$ and $3{\cdot}30 \pm 0{\cdot}1$ Å respectively. The latter value can be interpreted only with the assumption of a more or less realized co-ordinate link between O and Hg. Consequently the molecule has only the symmetry of a twofold axis and the crystal is a racemic mixture. A.

548.737

11. Skeletal units in protein crystals. D. WRINCH. *Science*, **115**, 356–7 (*March* 28, 1952).

The arrangement of amino-acid residues to form a "skeleton" which persists in some form or other in all globular proteins is discussed, with possible methods of interpreting Patterson syntheses on the assumption of such structures. A. J. C. WILSON

548.737

12. X-ray diffraction study of crystalline neopentane (tetramethyl methane). A. H. MONES AND J. POST. Letter in *J. Chem. Phys.*, **20**, 755–6 (*April*, 1952).

Single-crystal photographs near −50°C showed a face-centred cubic structure, and entropy measurements indicate much disorder; powder photographs at about −150°C indicated a tetragonal structure.

A. R. STOKES

548.74

13. On the theory of anomalous electron interference effects at crystals for glancing incidence. K. ARTMANN. *Z. Phys.*, **132**, 30–43 (*No.* 1, 1952) *In German.*

Calculations designed to account for the experimental curve of reflection coefficient as a function of the z-component of the wave vector as obtained by Yamaguti (1941). In these experiments electrons bombarded at glancing incidence a NaCl crystal having its (001) planes parallel to the surface. In the calculations described the potential used was the one-dimensional potential averaged over the x- and y-co-ordinates, and, with this effective potential, the one-dimensional Schrödinger equation has been solved. The periodic potential in the crystal and the gradual rise in the potential near the surface have been considered separately. With appropriate values for the parameters good agreement has been obtained with experiment. P. T. LANDSBERG

548.74

6214. Investigation of the degree of ordering of the gold-copper alloy $AuCu_3$ by electron diffraction. H. RAETHER. *Z. angew. Phys.*, **4**, 53–9 (*No.* 2, 1952) *In German.*

Thin single-crystal sheets (several hundred Å thick) of the alloy were obtained on a heated NaCl crystal by evaporation, and examined by electron diffraction after heating at different temperatures. The superlattice reflections show a fine structure below the critical temperature (388°C) which is explained by the existence of out-of-phase domains. Immediately below this temperature the fine structure disappears. Just above this temperature the superlattice reflections are still visible and again have a fine structure which disappears at 485°C. At 525°C the superlattice reflections themselves disappear. J. THEWLIS

548.74

6215. The use of gold leaf as a reference material in the determination of lattice constants by electron diffraction. R. I. GARROD. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 292–3 (*April*, 1952).

Lattice constants of Au and NaCl were determined using admixed graphite as a standard. NaCl gave results consistently in agreement with the X-ray value, but Au foil frequently gave an anomalously low value, which makes it unsatisfactory for reference purposes.

R. S. PEASE

548.74 : 539.185 : 535.42

6216. Neutron diffraction study of the crystal structure of ammonium chloride. H. A. LEVY AND S. W. PETERSON. *Phys. Rev.*, **86**, 766–70 (*June* 1, 1952).

The crystal structure of the room-temperature phase of ammonium chloride was determined by powder and single crystal neutron diffraction methods. The N–H links are directed essentially toward 4 of the 8 surrounding chloride ions, and, contrary to a recent report, the two orientations fulfilling this condition are occupied at random in the crystal. Thermal motion of the H atoms is non-spherical and suggests a rotatory oscillation of the ammonium ion as a whole with a half-angle of about 10°. The length of the N–H link is $1{\cdot}03 \pm 0{\cdot}02$ Å. The 2nd-order transition at −30°C is thus shown to be of the order-disorder type. A.

GEOPHYSICS 55

550.341

17. On the nature of seismic waves capable of traversing the core of the earth. L. CAGNIARD. *C.R. Acad. Sci.* [*Paris*] **234**, 1705–6 (*April* 21, 1952) *In French.*

Suggests that the discontinuity at the core boundary is one of electrical conductivity. In a conducting medium in a magnetic field elastic waves decay rapidly. If the conductivity is low and the field weak, a longitudinal and two transverse waves exist, but if the conductivity is high, all but one of the waves are attenuated rapidly. Unless a ray path begins or ends near a magnetic pole the only core wave that can be detected is transverse with the displacement in the plane of the magnetic field and direction of propagation. A. H. COOK

550.346 : 534.115

A study on the damping of longitudinal vibration of an elastic cylinder. *See Abstr.* 5607

550.384

6218. On the influence of irregularity of the earth's rotation on its magnetic field. N. STOYKO. *C.R. Acad. Sci.* [*Paris*] **234,** 1798–1800 (*April* 28, 1952) *In French.*

In an earlier note [Abstr. 9184 (1951)] it was claimed that a direct relation had been established between the rate of rotation of the earth and the total magnetic field at any station. This was based on results from European stations only. An analysis of results from 27 stations, well distributed over the globe, is now given, and is regarded as confirming the earlier conclusion. A. T. PRICE

550.834.3

6219. Seismic refraction shooting in an area of the eastern Atlantic. M. N. HILL. *Philos. Trans. A,* **244,** 561–96 (*No.* 890, 1952).

For the experiments described in this paper a new method of seismic refraction shooting was developed. With this method hydrophones suspended at a depth of about 100 ft below the surface of the sea acted as receivers for the compressional waves developed by depth charges exploding at a depth of approximately 900 ft. A.

551.243

6220. Physical aspects of the contraction hypothesis of orogenesis. A. E. SCHEIDEGGER. *Canad. J. Phys.,* **30,** 14–25 (*Jan.,* 1952).

Several geophysical arguments important in the theoretical consideration of the contraction hypothesis of orogenesis are analysed in detail with respect to their physical bases. Specifically, it is shown (*a*) that a thin surface layer of a sphere will fold in a smaller pattern than a thicker surface layer if the interior shrinks by the same amount; (*b*) that the speed of cooling of a sphere decreases if some radioactive and hence heat-generating material is moved from the surface towards the centre (and conversely); and (*c*) that at the level of no strain of a cooling sphere the temperature-depth curve must be almost straight. Those geological theories in which these considerations are important are indicated. A.

ATMOSPHERE . METEOROLOGY 551.5

551.510.535

6221. [Horizontal] movements of the sporadic *E* layer. N. C. GERSON. *Z. angew. Phys.,* **4,** 81–2 (*No.* 3, 1952) *In German.*

Observations in the U.S.A. of abnormal propagation on frequencies near 50 Mc/s made in June 1949 were used to track the large-scale movement of sporadic *E* clouds. The velocities deduced varied between 100 and 300 km/hr. W. J. G. BEYNON

551.510.535

6222. Lunar variations in *F*2 region critical frequency at Singapore. B. W. OSBORNE. Letter in *Nature* [*Lond.*] **169,** 661–2 (*April* 19, 1952).

Consideration of noon values of f_0F2 at Singapore and the age of the moon over the period Nov. 1948 to June 1951. A minimum of f_0F2 occurs a few days after full moon at all seasons, and also after new moon during the June solstice. A lunar control of the times of appearance of ledges in the *F*2 layer (when this is thick) is also apparent. G. M. BROWN

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 5929, 5931–2

551.557 : 538.556.3

6223. A radio-astronomical investigation of winds in the upper atmosphere. A. MAXWELL AND C. G. LITTLE. Letter in *Nature* [*Lond.*] **169,** 746–7 (*May* 3, 1952).

Observations at 3 sites approximately 4 km apart of the fluctuations in radiation on 80 Mc/s from radio stars often show appreciable correlation. The small time displacement between corresponding fluctuations observed at night are attributed to the motion of irregularities in region *F* of the ionosphere and estimates are made of the velocities of such irregularities. W. J. G. BEYNON

551.577.37 : 551.594.14

6224. Researches on atmospheric precipitation on a global scale. H. GARRIGUE. *C.R. Acad. Sci.* [*Paris*] **234,** 1571–3 (*April* 7, 1952) *In French.*

It was shown in an earlier paper that the radioactive pollution of the air at mean heights diminished from 1946 to 1951. The change still continues in France. Climatological data have been used to obtain monthly mean values of rainfall for 8 regions of the earth for 1949 and 1950. These show an increase of rainfall and it would result in part at least for a decrease of radioactive pollution of the atmosphere. It depends, however, more on duration than amount of rainfall. R. S. REAH

551.593.5

6225. Measurements of the brightness of the twilight sky. M. J. KOOMEN, C. LOCK, D. M. PACKER, R. SCOLNIK, R. TOUSEY AND E. O. HULBURT. *J. Opt. Soc. Amer.,* **26,** 353–6 (*May,* 1952).

With a recording photometer of photopic sensitivity measurements were made of many points in the sky during twilight for solar altitudes $H = +5°$ to $-15°$ for clear air and no clouds at two stations, one in Maryland, altitude 30 metres, and one on Sacramento Peak, New Mexico, altitude 2800 metres. The sky polarization on the meridian through the sun, and the illumination on a plane at various orientations exposed to the sky, were also recorded. For H from about $-3°$ to $-11°$ the entire sky changed in brightness at about the same rate of a factor of 10 for each 2° change in H. Except at the horizon the Sacramento Peak sky was about $\frac{3}{4}$ to $\frac{1}{2}$ as bright as the Maryland sky because of clearer air; at the horizon the two were about the same. At Sacramento Peak the ratio of the polarized components reached a minimum of about 0·06 at the zenith for $H = -3°$.

551.594.2

6226. An investigation of point-discharge currents. H. L. ALLSOPP. *S. Afr. J. Sci.,* **48,** 244–6 (*March* 1952).

An electronic point discharge recorder is described capable of detecting currents exceeding 0·1 mA

servations made in Durban, South Africa, on thunderstorm days produced a total of ~45 mC flowing charge. While the majority of storms icate negative charges in the lower regions of the id, two storms gave evidence of positive pockets previously observed at Kew. R. H. GOLDE

551.594.5

7. Excitation mechanism of the luminescence of ar lights. I. S. SHKLOVSKIĬ. *Dokl. Akad. Nauk SR*, **81**, 525–8 (*No.* 4, 1951) *In Russian.*

The weakness of the permitted lines of O and N mpared with the forbidden lines can be explained the excitation potentials being low for the latter l high for the former. The existing theories ating to the excitation mechanism of the negative tem of N molecules in polar lights are criticized, l a selective mechanism is suggested, based on the umption that the negative system is the only kind of emission proper to ionized particles. It is claimed that the only possible elementary process is the reaction (transference of charge) between the primary proton (or ionized He) with a N molecule, yielding an ionized N molecule $[N_2^+(A^2\Sigma)]$. F. LACHMAN

551.594.5

6228. Laboratory reproduction of auroral emissions by proton bombardment. A. B. MEINEL AND C. Y. FAN. Note in *Astrophys. J.*, **115**, 330–1 (*March*, 1952).

Laboratory spectra (dispersion, 400 Å/mm) of the emissions excited by a proton beam in air show striking similarity to the aurora, far more so than when electronic excitation is used. It is uncertain whether the new effect explains the auroral spectrum more correctly than does the electron discharge, since the two mechanisms are basically different. Further expts. with electrons accelerated to high energy *in vacuo* should provide a crucial test. D. R. BARBER

BIOLOGY 57/59

57 : 530.145

59. The significance of complementarity for the sciences. W. G. POLLARD. *Amer. J. Phys.*, **20**, –8 (*May*, 1952).

A suggestion of Bohr's to the effect that numerous ations exist among the life sciences and the social ences which exhibit characteristics of comple- ntarity strikingly parallel to those of quantum ysics is developed further in this paper. The position is advanced that there may exist for logical systems inherent relations of indeterminacy ween sets of observable properties of such systems alogous to the Heisenberg indeterminacy relations ween canonically conjugate pairs of observables in antum mechanics. The existence of such indeter- nacies would be manifested, as it is in physical tems, in disturbances, uncontrollable in principle, duced when such systems interact with instruments d apparatus used to gain information about them. rther progress in scientific explanation and synthesis knowledge in these fields would then require a lefinition of the state of a biological system alogous to the necessity for using quantum unctions for specifying the state of a physical tem with the attendant possibility of wholly new ights, such as those in physics which ultimately pend on the symmetry properties of ψ-functions. A.

578.087.86 : 536.532

Measurement of respiratory air temperature. *See str.* 5749

578.087.87 : 621.395.645

30. Noise in amplifiers; its reduction—application physiology. B. BLADIER. *Acustica*, **2**, 23–34 . 1, 1952) *In French.*

In this paper are expounded the principles on which w-noise, high-gain amplifier (22×10^6), particularly table for physiological studies, was developed. The plification is limited to the very low frequencies to approximately 500 c/s); but amplitudes of about 4 μV can be observed. It is particularly suited to the detection of the γ-waves in electroencephalography. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612 : 539.16.08

6231. Body composition: studies in the human being by the dilution principle. I. S. EDELMAN, J. M. OLNEY, A. H. JAMES, L. BROOKS AND F. D. MOORE. *Science*, **115**, 447–54 (*April* 25, 1952).

Radioactive isotopes are injected intravenously, allowed to reach uniform distribution, and from the dilution achieved at equilibrium, various body constituents can be measured. The method is described in the case of plasma and blood volume, extracellular fluid volume, total body water and total exchangeable Na and K. Values for all these factors are given from tests on a young normal male. The method is also of value in studying metabolism in the post-operative patient. D. V. MABBS

612.843.611

6232. The effect of extending the duration of various light-dark ratios of intermittent pre-exposure upon dark adaptation in the human eye. F. A. MOTE AND F. C. REED. *J. Opt. Soc. Amer.*, **42**, 333–8 (*May*, 1952).

The influence of intermittent *v.* continuous pre-adaption upon subsequent dark adaptation was investigated for two durations of the continuous: 1½ and 3 minutes. The rate of intermittence for the discontinuous condition was 1 c/s and 4 light-to-dark ratios were employed. The pre-exposure intensities were 8860, 886, 88·6 and 8·86 mL. Differences were found for most of the cases in which a comparison was made between the curves of dark adaptation following the two conditions of preadaptation. For the intermittent condition at the highest pre-exposure intensity it was found that the shorter the light-time

in the ratio, the lower the initial threshold tended to be and the more rapidly the final dark adapted threshold was reached. At the two lower intensities the initial thresholds for both the intermittent and continuous curves were approximately the same, but the curves for the intermittent were markedly retarded in reaching the final level of dark adaptation. A.

612.858.71

6233. Methods of measuring the threshold of hearing. F. J. MEISTER. *Arch. tech. Messen, Issue* 193 (*Ref. V*666–2) 29–32 (*Feb.*, 1952) *In German.*

The paper deals with the various methods of measuring auditory acuity over a range of frequency 10 c/s to 10 kc/s. Refers to Fowler's method, Békésy-audiometer method, and the method of Lüscher Zwislocki. The arrangement using octave filters in mon-aural comparisons is also described.

A. B. WOOD

614.48 : 537.531 : 537.533

6234. 2 MeV X-ray and cathode-ray irradiation of pseudomonas aeruginosa. W. S. MOOS. *Experientia*, **8**, 105–6 (*No.* 3, 1952).

The bactericidal effects of 2 MeV X-rays and cathode-rays produced by a Van de Graaff generator were studied. The techniques of mounting, exposing and counting the bacteria are described. Experimental curves given show an exponential fall of percentage survival with increase of dosage. There is good agreement between measurements for absorption of 2 MeV cathode-rays in Al when made by ionization chamber, photographically and by the present method.

D. V. MABBS

614.48 : 539.16

6235. Control and removal of radioactive contamination in laboratories. *Handb. U.S. Bur. Stand., No.* 48, 24 *pp.* (1951).

Emphasis is laid on the importance of adequate training for personnel, and the observance of all the well-known precautions against accidents with radioactive substances. Permissible levels of contamination, and decontamination procedures, are fully discussed under the headings: contamination of skin, clothing and bedding, laboratory tools, furniture and glassware. Possible emergencies are considered at length. An appendix lists detergents and wetting agents found to be satisfactory. D. V. MABBS

614.75

6236. Recommendations for waste disposal of phosphorus^{-32} and iodine^{-131} for medical users. *Handb. U.S. Bur. Stand., No.* 49, 11 *pp.* (1951).

These recommendations consider the permissible concentrations of radioactive waste, and formulate rules for disposal practice, largely from the point of view of the general community, and especially of sewage-plant workers. Some method of dilution during disposal is advocated if the sewage flow is known to be small, or if large quantites of radioactive waste are concerned. Appendices describe (1) practical examples in the calculation of sewage contamination and (2) a constant pressure drip discharge arrangement for controlled disposal of radioactive waste. D. V. MABBS

614.898

6237. Photographic protection measurements with X-rays, gamma and beta rays. G. SPIEGLER. *Photogr. J. B*, **91**, 128–33 (*Nov.–Dec.*, 1951).

In the light of the author's experience at the Royal Cancer Hospital, a detailed review is given of the whole subject of providing an adequate estimate of stray radiation received by exposed personnel. The dependence of photographic sensitivity on the energy of received radiation is considered over the range 45 keV–24 MeV, and "energy factors" are evolved for each quality, enabling calibration of films to be made under one standard condition. The stray dosage is interpreted as a fraction of the tolerance value. An indication is given of the use of the photographic method in measuring areas of stray radiation with large films. D. V. MABBS

614.898 : 539.16.08

6238. Radiological monitoring methods and instruments. *Handb. U.S. Bur. Stand., No.* 51, 33 *pp.* (1952).

The report attempts to establish basic guides for methods of determining radiation hazards and for selecting the appropriate instrument for measuring them. It is detailed, though succinct. Chapters are headed: (1) The general radiation hazard. (2) Radiation detectors. (3) Measuring instruments. (4) Personnel monitoring instruments. (5) Requirements in design. (6) Radiation-survey methods. An appendix contains information on air and water analyses and on α- and β-ray counting. D. V. MABBS

PHOTOGRAPHY 77

778.34 : 537.534.74

6239. Theoretical introduction to the methods of measuring multiple scattering [of charged particles] in photographic emulsions. B. D'ESPAGNAT. *J. Phys. Radium*, **13**, 74–80 (*Feb.*, 1952) *In French.*

A critical survey is given of existing methods of measuring small-angle scattering, with special reference to experimental procedure and to the accuracy obtainable by each method. A. C. COATES